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CONTENTS.

	PAGE.
Gold Coast Cocoa	109
Tomatoes in the Canaries	111
The World's Cotton Markets (*To be contd.*)	113
The Sugar Problem	116
Entomology in the Tropics	119
Soil Erosion	123
Biological Control	124
The Bird of Paradise	127
Froghopper Ecology	127
Rubber in 1930	130
Tropical World Notes	131
Chemical Notes	132
Sugar Notes	133
Mycological Notes	134
Reviews	135
Trend of the Markets	136

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GOLD COAST CACAO.

THE publication of the Gold Coast Department of Agriculture's Yearbook* for 1929 has again drawn our attention to the problems which have arisen out of the exceptional development of the cacao industry in that Colony. The Department has within recent years been considerably strengthened and as presently organised, may be said mainly to be directing its energies towards improving the quality of Gold Coast cacao and eliminating as far as possible those factors which lead to wastage in its production and marketing. An interesting programme of work is being carried out on these fundamental problems, and as would be expected, the greater part of the Yearbook is concerned with them. It also includes a number of valuable papers on other subjects.

The Director's views on the problems connected with the storage of cacao in the Gold Coast may be quoted in full. "In the past," he says "it has not been a general custom to store cacao for very long periods on the Gold Coast. The aim of buyers has usually been to transfer stocks to Europe with the minimum of delay found possible. This tendency towards rapid shipment was dictated by a real fear that quality would deteriorate more quickly under the conditions of storage existing on the Coast than in warehouses in temperate climates.

There can be very little doubt that this fear was justified in the early days of the industry, when methods of preparation and drying were thoroughly inefficient and local methods of storage very primitive. Inadequately dried cacao would be sold by the farmer in small lots, retained by the small broker until lots of fair size could be made up, and finally held by the exporter until adequate shipments had been accumulated. Even in the last case provision for storage was not infrequently insufficient, and shipments were kept in the open or in badly protected or unventilated buildings.

There are two major sources of expenditure which accompany the system of storing in Europe and which would be avoided if stocks could be held on the Coast until finally sold to manufacturers. In the first place, handling from warehouses is doubled, since stocks have first to be stored on the Coast and then held in Europe until final sale. Secondly, there is in many cases unnecessary sea transport, since shipments eventually sold, say, to America, are distributed

* Bulletin No. 22, Dept. of Agric., Gold Coast, 1929.

from Europe instead of being sent direct from the Coast. A third not inconsiderable item of avoidable expense is the higher cost of handling and storage in warehouses in Europe as compared with those on the Coast.

When the world's demand for cacao exceeded the supply, and sales were rapid and prices high, the disadvantages of the system were not as noticeable as they have now become. In many cases it must have been possible to effect sales while the produce was still in the Colony and so save the double handling, and, in any event, it was not so necessary to reduce costs. Nowadays, with supply in excess of demand, the position is very different, and every effort must be made to cut out all unnecessary expense."

From investigations already carried out by the Department, it has been established that whereas the atmosphere at up-country centres is too damp to permit of long storage, at Gold Coast ports it is dry enough to allow storage of well prepared cacao for periods up to 15 weeks. It has also been found that at present, too long an interval (about 70 to 80 days) usually elapses between harvesting the crop and bringing the produce to port and that this period could be shortened by cutting out intermediate sales and avoiding bulking, redrying and bagging. Experiments on the response of dried cacao beans stored in bags to changes in the relative humidity of the atmosphere have shown that cacao, having a moisture content of less than eight per cent. and stored in an atmosphere whose average daily relative humidity is less than 82 per cent. is not liable to fermentation during storage. Excess moisture in the bean is the controlling factor governing quality and as the farmer cannot be relied upon to dry his produce thoroughly it is recommended that Departmental certificates should be issued which would give the percentage of moisture in all lots inspected. Other problems connected with the storage of cacao include its ventilation at ports, the point of whether cacao loses its powers of absorbing water from the air if it is dried thoroughly after fermenting (this is being investigated), and the need for comparative figures for relative humidity inside and outside stores in the United Kingdom and the Gold Coast. The general opinion of the Department is that "with sound preparation and storage accommodation comparable in efficiency with good warehouses in London or Liverpool, it should be possible to keep cacao for long periods in the Gold Coast without serious deterioration".

Another urgent problem in the Gold Coast, as already pointed out, is the improvement in quality of the cacao produced. It is hoped to bring this about by encouraging the formation amongst peasant farmers of a large number of co-operative selling societies and by inaugurating a certification scheme to eliminate certain local expenses which at present detract from the farmers' profits. This would ensure for Gold Coast cacao a higher relative price in the world's markets. Part of the Departmental programme has accordingly been directed to the development of the co-operative movement. Thirty-one societies have already been formed of which twenty-seven are Cacao Producers'. There is no doubt that the quality of cacao produced by the co-operative societies is much higher than the average and from the results already available it would appear that a sound type of cacao marketing society has every chance of being successful in the Gold Coast.

Other investigations reported in the Yearbook include the collection of data on the size of cacao farms and cacao statistics. A scheme for forecasting the size, earliness and distribution of the cacao crop has also been designed, the data for which will be collected from plot records kept on native farms throughout the cacao areas. The period of flowering of cacao has been ascertained from botanical studies in flower and fruit production. It is interesting to note that the number of flowers setting fruit does not exceed 2.5 per cent., that the shedding of flowers is as high as from 97.5 per cent. to 99.4 per cent. of those opening, while only 0.20 per cent. to 1.5 per cent. of the opening flowers develop fruit. The majority of pods ultimately reaching maturity attained maximum size in seventeen to eighteen weeks. Certain manurial trials have indicated that cacao generally responds to applications of manure, and chiefly to the application of basic slag which appears to have a beneficial effect in increasing the yield of cacao. It would appear also that heavy mulching has a tendency to increase the percentage of useless pods. The most severe insect pests of cacao in the Gold Coast belong to the *Sahlbergella* spp. As it was believed that these pests might possibly have been introduced into the Gold Coast from San Thomé or Fernando Po, from which they had not been recorded, an entomologist visited these two islands with a view to finding natural enemies. The visit was extended to the Belgian Congo where *Sahlbergella* is known as a pest. In spite of a careful search, no species of *Sahlbergella* was found to occur in San Thomé although *S. singularis* was found to be common in Fernando Po. and in the Belgian Congo; neither were any natural enemies in addition to those already known in the Gold Coast found in the countries visited.

The above briefly summarises a few of the Gold Coast Department of Agriculture's activities with regard to the cacao crop. Those who wish to study them in greater detail cannot do better than consult the Yearbooks which have been issued regularly by this Department within the last few years.

RANSOMES, SIMS & JEFFERIES.

OUR thanks are due to *Messrs. Ransomes, Sims and Jefferies* for presenting us with a number of copies of beautifully illustrated pamphlets, which we understand will be displayed at the Buenos Aires Exhibition. These pamphlets, which are written in Spanish, contain much useful information on the types of agricultural and garden implements manufactured by this firm.

TOMATOES IN THE CANARIES.

By E. Holmes, Ph.D., A.I.C.

In a recent article (1) the writer gave some details of banana cultivation in the Canaries. It has now been suggested that, in view of the increasing export of tomatoes from the West Indies to Canada, a similar article on that crop would be of interest. The following describes tomato production as conducted under the conditions already described. The writer would thank cordially members of the staffs of Fyffes Ltd., and R. J. Yeoward for help in collecting much of the information contained in these two articles.

Introduction.

Tomatoes are cultivated in the coastal regions of the Canaries up to an altitude of about 1,000 feet, or a little higher on the southern coasts. Cultivation in the higher regions above 500 feet, gives a considerable proportion of "turnipy" tomatoes, below 500, a softer, more tropical fruit. The main production is in Grand Canary, Teneriffe, Gomera and Palma, and a small quantity is exported from Fuerteventura and Lanzarote *via* Las Palmas. After bananas, tomato cultivation is certainly the most lucrative of agricultural pursuits, and it is stated to have increased in Grand Canary by 100 per cent. in the last five years. Rather more than 7,000 acres are under tomatoes annually in the Canaries.

In general, light soils are used for tomato cultivation, and when small amounts of organic manure are incorporated with them they give much better results than do the heavy soils. Tomatoes are cultivated on terraces and levelled land in soils similar to those used for bananas, but usually in districts having insufficient supplies of water for the latter crop. In these districts there is usually plenty of unreclaimed land available, but not much water to make it productive, with the result that land is seldom cropped with tomatoes for more than one or two years, after which it may be used for lucerne, beans, maize or potatoes, or left derelict and the available water diverted to newer land.

Tomato Planting.

On the best plantations seed beds are prepared by fining down the soil into small shallow beds of approximately 2½ square yards in area, and about 500 seeds are planted in each bed, a few seeds in each of the holes which are spaced at 2 by 2 inches. Usually, however, the seeds are just broadcast carelessly in the seed beds, far too little trouble being taken at this stage. Sowing of seed goes on from June for the earliest tomato exports, *i.e.*, October to November export, right through into February for the latest tomato exports in the following June. Seed is usually brought from England and acclimatised but, whereas the bananas grown in the Canaries are entirely of one variety, the Cavendish, the tomato crop is derived from anything up to 50 varieties, or strains of varieties, of which perhaps 6 predominate. As a result the utmost difficulty is experienced in grading the different consignments at the packing houses. Varieties being grown in different districts at present include:

Chalk Farm Cropper (now known as Hoya No. 2),
Hillside Comet,
Prince of Wales, and
Bide's Recruit.

A strain of Hillside Comet was used very largely before the War, but Prince of Wales has been used considerably since. The latter variety generally develops very little leaf so that tomatoes are apt to scorch owing to insufficient shade. Hillside Comet is inclined to give split fruit, especially on the east side of the islands. Bide's Recruit gives very large total yields of tomatoes, but whereas the ordinary varieties give only six to seven per cent. of small tomatoes, this variety sometimes gives 40 per cent., and usually 20 to 30 per cent. of "smalls." As a result 10 to 15 per cent. of the usual selling price is sacrificed.

It is estimated that the ordinary peasant uses as much as ten to fifteen times the amount of seed he really needs through carelessness in sowing and planting.

Tomato Transplanting.

After the seeds are sown the seed beds are given a very light watering, and when the seedlings are three inches high they may be watered lightly with water containing a little ammonium sulphate. After about a month the seedlings are transplanted 18 inches apart in ridges two feet apart. The plants are hand-set half-way down the sides of the ridges of the field, and 12,000 plants are usually planted per fanegada (approximately 1⅓ acres).* This figure, however, may be as high as 14,000; 16,000, or even 18,000, depending upon the spacing of the ridges made by crude ox-drawn ploughs. Twenty-five days after transplanting, the ridges are hoed and the side of one ridge without plants is scraped away and used for earthing up the plants on the side of the next ridge. Tomatoes require about 300 upright and 300 horizontal canes, each about seven to ten feet long, per 1,000 plants.

The Use of Manures.

Ammonium sulphate or a complete fertilizer is applied to tomatoes in three amounts of 50 to 100 lb. per 1,000 plants, (a) at transplanting, (*b*) at the first hoeing, and (*c*) at the second earthing-up 20 to 25 days after the first. Ammonium sulphate is used at (*a*) and complete manures at the other times by most farmers. The mixtures, known locally as "guanos", are variations of the following which may be taken as typical:—

Ammonium sulphate	40%
Superphosphate (17 per cent. P_2O_5)	32%
Potassium sulphate	23%
Calcium and/or ferrous sulphate	5%

* The fanegada varies from 1.29 to 1.36 acres in the different islands.

This mixture contains 8.2 per cent. of N, 5.4 per cent of P_2O_5 and 11.0 per cent of K_2O. In general it may be said that the complete manures used on tomatoes contain seven to nine per cent. of N, five to six per cent. of P_2O_5, and 10 to 14 per cent. of K_2O. The total amounts applied vary from a half to four tons per acre per annum, the usual being two and a half to three tons.

It is of interest to note that a 3.9 : 9.3 : 7.2 (N : P_2O_5 : K_2O) mixture, based on an English recommendation, failed under Teneriffe conditions, whilst a 9.5 : 5.9 : 5.8 mixture tried alongside gave excellent results. It should be stated that the latter mixture is very low in potash when compared with those most popular.

A further 5.4 : 9.3 : 7.2 mixture is a recommendation of the Agricultural Service at Santa Cruz, and, from its relatively high P_2O_5 content, appears to be based on English or American practice. The writer was unable to ascertain whether anyone was actually using a mixture of this formula.

Sulphur may be applied to tomato plants three times during growth, both as an insecticide and as a fungicide, the amounts used being about 6, 12, and 18 lb. per 1,000 plants according to their stage of growth. Occasionally it is applied in the seed beds. There is no definite rule about the application of sulphur ; its use depends upon zone and climate. General practice, however, demands the total application of 1,500 to 2,000 lb. of sulphur per acre per annum.

Time of Harvesting and Yield of Tomatoes.

The crop is ready for harvesting from 3½ to 4½ months after sowing and for the export trade the fruit is picked when the underside of the calyx sepals shows yellowish with dark coloured lines, and when there are a few reddish streaks on the underside of the fruit. At this stage the main portion of the fruit is quite green.

The yield of tomatoes per plant varies enormously in the different districts, *e.g.*, at Telde on worn-out land the average is probably 2 lb., at Galdar with rather poor cultivation the average is probably 3 lb. per plant, whilst at Carrisal the average is about 3½ lb. on new land. In the south of the islands the usual average is about 4 lb. per plant with bad cultivation and 5 lb. per plant with better cultivation, whilst at Sardinia on the south-east coast of Grand Canary the average is probably five to six lb. per plant but with rather a high percentage of "smalls". One firm usually averages about four lb. per plant on its plantations with poor cultivation in the south of Grand Canary, where the climate is particularly favourable, but it is considered that this could be raised to seven lb. per plant with good cultivation if it were economic to carry out the extra work. The above figures refer to "exportable" fruit.

The production of tomatoes on plantations in two districts in south-west Teneriffe in 1929 may usefully be summarised :—

	Area (fanegadas)	Total plants.	Yield	
			Total.	Per plant.
			(1000 lb.)	(lb.)
(1)	83.25	833,067	2,173	2.61
(2)(*a*)	35.00	393,505	1,357	3.45

(*a*) The harvest was not quite complete on this plantation when the figures were obtained.

According to W. Ruschmann (2) the yields obtained on a particular plantation at Orotava during three seasons were :—

Season.		*Yield.*
1921/22	....	19,600 (lb./acre)
1922/23	....	13,700 do.
1923/24	....	15,300 do.

These figures were calculated from the yields on sets of plantations varying between 6½ and 11 acres in the different seasons. The highest yield ever recorded in this district is given as 21,200 lb. per acre.

Before packing, tomatoes are graded according to size and the following figures due to Ruschmann show the percentages of the different grades on this plantation in the season 1923-24.

Grade		*Per cent.*
G	....	5.77
M	....	8.95
MG	....	4.86
MM	....	33.30
MP	....	24.93
P	....	14.78
PP	....	7.41

Fruit is now running rather smaller than this owing to the prevalence of the variety "Bide's Recruit," and acclimatized strains of this variety. It is probable that the total percentage of the smaller grades, MP, P and PP, is now 70 per cent. of the crop rather than the 47 given in the table.

There is, of course, no such thing as uniform grading, but the following may be taken as the average at the present time :—

Grade	Average percentage of fruit in grade.	Average number of tomatoes per box.
G	2	48
M	6	60
MM	9	72
MMM	12	84
MP	28	112
P	25	160
PP	18	240

The tomatoes are usually packed in wooden boxes 7 by 16 by 9½ inches and each box holds from 14 to 18 lb. with about 5½ lb. of packing material including paper, peat and sawdust. The unit usually used in referring to exports of tomatoes is 1 *atado* or bundle, which consists of four boxes, total weight about 85 to 95 lb., or a net weight of from 60 to 70 lb. of tomatoes.

TOMATOES IN THE CANARIES.

(1) *Typical unredeemed land with characteristic cactus, "Euphorbia Canariensis," on left.*

(2) *Ploughing soils with primitive implements.*

TOMATOES IN THE CANARIES.

(3) *View showing seed beds such as are prepared on the better plantations.*

(4) *End-of-season fruit.*

Shipment of Fruit.

Owing to the fact that most fruit shippers obtain their supplies of tomatoes from numerous farmers (bought fruit), from their rented farms (fruit produced more or less under supervision), and from their own farms (where they have complete control of the cultivation), it is realised that packers are called upon to grade and carry tomatoes of all sorts of varieties produced under a wide variety of conditions of climate, soil, irrigation and manurial treatment. As a result it is not surprising that some tomatoes arrive on the market in perfect condition while others in the same box have either ripened or rotted in transit.

The tomatoes are normally picked in such a condition that they will be fit for consumption after allowing 15 to 20 days between harvesting and use.

All tomatoes packed in the winter months, especially December and January, go below deck during the voyage and at least one firm retains a few boxes of each consignment in Teneriffe, to be opened after 3, 6, 9 and 12 days to look for disease or other defects. Although these boxes, which may be regarded as control boxes, are kept at a higher and more uniform temperature in Teneriffe, their condition on opening furnishes some guide as to what may have happened to the boxes in the consignment shipped.

A bundle of tomatoes may fetch anything from 10 shillings to 35 shillings on the London market. This price obviously varies in different seasons, but it may average 21 shillings per bundle in October-November, 15 to 16 shillings in December-February, and up to 25 shillings or more in April and May, consequently the bulk of the crop is shipped during March, April and May. Fruit for seed, which represents not more than a ½ per cent. of the total crop, may be allowed to ripen and is picked during those months in which the price drops to its lowest point. Most seed, however, is taken from good fruit that has split or been allowed to become over-ripe, at any period. A few of the best firms grow special seed crops, the only practicable way of obtaining uniform seed.

Tomato Exports from the Canaries.

Destination.	Bundles, each approximately 60-70 lb. net of fruit. (1,000's)				
	1926	1927	1928	1929	1930
U.K.	1,497	1,750	2,060	2,095	2,443
France	10	30	46	82	94
Spain	40	69	123	100	120
Germany	143	239	300	355	633
Holland	10	17	13	13	11
Denmark	1	4	2	2	—
Totals	1,701	2,109	2,544	2,647	3,301

References.

(1) *Tropical Agriculture*, 1930, Vol. VII, No. 12, pp. 320 to 325.
(2) *Tropenpflanzer*, 1924, Vol. XXVII, pp. 137 to 141.

THE WORLD'S COTTON MARKETS.

By John A. Todd, M.A., B.L.

In a previous article ("Cotton Prices—Supplies and Consumption," Vol. VII, No. 12, pp. 326-331, December, 1930) the writer discussed the recent movements of cotton prices which have made the year 1930 one of the most remarkable in modern history. Since that article was written (in September, 1930), things have gone from bad to worse and cotton prices have touched the lowest figure since 1911, except of course for the brief period of total collapse in the early months of the war, but even these two previous records were not much lower than 1930. Other commodities have been even worse; silver and rubber have established new low records for all time, while wheat has been lower than anything recorded since the 17th century.

Elsewhere* the writer has recently been discussing the causes of this world fall of prices in which cotton has had its full share; but while these general conditions have admittedly been the dominant factor in cotton prices during the past year, those whose livelihood depends on cotton are more directly interested in the particular conditions affecting their own staple, and in the world's markets through which these conditions operate. It has therefore been thought desirable to try to give cotton growers a fairly simple account of what that system of markets really is. It is perhaps natural that when the grower is not pleased with the price he gets he should blame the marketing system; and in recent years there has been, especially in America an enormous amount of criticism of the cotton markets, especially the Futures markets of the great world centres, much of which has in the writer's view, been "barking up the wrong tree". In this article therefore he proposes to attempt a description of the whole process of cotton marketing from the grower to the spinner, and to show how these markets work in fixing the price.

The question really resolves itself into two (1) What are the considerations, both of demand and supply, which affect the value of cotton in general or of any particular cotton; and (2) How do the various world's markets operate in ascertaining these values? Under the first heading the primary question is how what may be called the intrinsic value, *i.e.*, the spinning value, of any particular cotton is fixed. Those who are familiar with the work of Dr. Lawrence Balls on this subject, particularly his *Studies of Quality in Cotton* (Macmillan 1928) will know that this question is still very far from being scientifically answered; but it will serve the purpose to say that the prime factor in the spinning value of any cotton is length of staple, though this is complicated by considerations of strength, uniformity and that very vague quality which the cotton buyer describes as "character". Again the market value of cotton is affected by

* The Fall of Prices. Oxford University Press, 1931

its "grade", in the limited sense in which the cotton trade uses the word, *i.e.*, its condition and colour, and particularly the quantity of dirt and foreign matter which it contains and which must be removed in the cleaning process. This with the question of short staple, which must be taken out in carding, affects the percentage of waste from any given sample of cotton, which of course directly affects its value to the spinner.

The range of quality of the numerous cottons is enormous, the staple for example running from $\frac{3}{8}$ ins. for the shortest Indian varieties to over 2 ins. for the best Sea Island, and the uses to which these different kinds of cotton can be put vary as greatly. Every spinner must have cotton good enough for the particular kind and quality of yarn he has in view; but no spinner wants to use cotton which is better, and therefore more expensive, than is necessary for his purpose. The first business of the cotton market therefore is to see that every bale of cotton finds its proper home, *e.g.*, if it is good cotton, the broker's business is to find a spinner who requires good cotton for a fine yarn, which will justify paying a good price for the cotton. But many fabrics require only a low grade yarn which must be cheap; and it is the broker's business to find the cheapest possible cotton that will serve that purpose. Thus every different type of cotton is competing with every other variety, and substitution of one variety for another is the order of the day, especially in recent years.

But competition and substitution are not confined within the range of different types of cotton. Cotton of all kinds has to compete with other fibres, *e.g.*, silk, wool, linen and now most particularly with artificial silk, for modern fashions include an enormous range of fabrics, some of which may consist of different fibres like cotton and artificial silk together; and the changes of fashion are constantly affecting the strength of this competition, *e.g.*, in one season the demand may be all for mixed fabrics, while in another there may be a swing over to fabrics which are all artificial silk or all cotton. Again within the range of different types of cotton, demand may change greatly. At times the demand seems to be all for short cottons, and longer stapled varieties are a glut in the market; while at other times the demand seems to swing quite the other way and low grades are at a discount. It is the cotton broker's business to be well informed of all these changes and how they affect the demand for the different staples and types of cotton.

But all the time he has to keep constantly in touch with the other side of the market, the fluctuations of supply, *e.g.*, not only the major question of the supply of American cotton which, as explained in the previous article, still dominates the world's markets for cotton as a whole, but also the particular movements of the supply of different kinds of cotton, such as the relative quantities of Sakel and Uppers in Eygpt, including the Sudan, the amount each year of the Mississippi Delta long staple cottons, the failing supply of Texas $1\frac{1}{8}$ ins. and the extent to which it can be replaced by East African cotton or Argentine or Russian, and so on; or the improving qualities of certain Indian varieties which put them in a position to compete with American cotton.

All this is the business of the Spot market, and it may be said without hesitation that in the Liverpool Spot market the necessary organisation of such a market has been carried to a point about as near perfection as anything could be. The system under which one class of brokers, known as Buying Brokers, confine themselves almost entirely to acting as agents for the spinners, giving them the full benefit of their accumulated experience of the qualities of the cotton, the kind of cotton that the spinner wants for his particular work and the whole market conditions on the side of supply, is one of the best examples of the advantages of specialisation. Under this system Lancashire is exceedingly well served, for Liverpool is the largest Spot market in the world, and literally every kind of cotton that the world produces is dealt in there. But Liverpool is only as it might be called the final Spot market. From the time the cotton is grown till it reaches Liverpool it has passed through many minor markets, and it is admitted that the conditions in many of these primary markets leave a great deal to be desired. Take for example American cotton. The American Cotton Belt covers an area of about 700,000 square miles spreading through 18 states. Over the greater part of this area the first market, and the only one that most of the growers are in touch with, consists of the little village or small town market to which the planter brings in his cotton, probably one bale at a time on his own waggon straight from the ginnery. When he left the plantation the waggon contained 1,500 lb. of seed cotton, the result of one or more days picking, and after waiting at the ginnery, perhaps overnight, he gets it back in a 500 lb. bale of lint. With this he proceeds to the village market, which is simply the main street of the village, where he finds a number of "street buyers", one or more of whom will sample his cotton and make him a bid, based on the latest quotations from New Orleans or New York, which the buyer knows but the planter probably does not. These buyers may be representatives of a big shipping house in the nearest large town such as New Orleans, Dallas or Atlana, but some of them are merely "scalpers" who buy as many bales as they can raise credit for, in the hope of reselling them to a larger house at a small profit. The local banker or store-keeper is also a potential buyer, especially as one of them has usually advanced money to the grower.

In fixing the price very little attention is paid to the staple of the cotton, and not very much to the grade, for it will hardly be believed that a great many even of the buyers themselves are entirely unqualified to give a reliable verdict on the staple of the cotton, while the planter

knows even less about it. In America there has grown up a system known as "hog-round buying" under which all the cotton is bought on a rough average for the district. The buyers know roughly what kind of cotton is mostly grown in that district, and they fix a price which represents approximately the value of such cotton, allowing a little margin for clean white cotton as against dirty weather stained cotton, and of course they take care to see that the price they pay is a safe average for them. The result is that any planter who has grown better staple cotton than his neighbours gets nothing extra for it, and this system is probably the greatest single obstacle that those who are trying to improve the staple of cotton have to fight against in every country.

When the cotton reaches its concentration point it is gone over by the owners who sort it out into lots of say 100 bales of about the same grade and staple, and proceed to dispose of it as best they can to merchants or spinners either in America or abroad, offering to the buyers either on sample or sometimes by "type" which is really just a standing sample. In America this habit of selling on type is not often used for more than a few months, but in Eygpt the types are permanent and are maintained from one season to another, often for many years. In this process of lotting out the shippers may secure a good many bales of fairly good staple cotton, the value of which will be well above the "hog-round" price they paid for all they bought; but if their buyer has not done his work well they may be landed with a great many bales of poor cotton which will have to be sold at a loss or may lie on their hands unsaleable for a long time.

It is difficult to avoid strong language in describing this system, which is just about as far away from the proper functions of a market as anything could be. There are of course exceptions, *e.g.*, there are what the merchants know as "staple points", districts where they can rely on the bulk of the cotton being of decent staple, and there are also some merchants who buy on "staple", *i.e.*, who give the proper price for every bale; but this of course restricts them to dealing at the staple points, because they cannot have buyers in every small town simply on the off chance of picking up a few odd bales of staple cotton. Again of course any planter who is big enough to forward his bales to a reputable firm in one of the big centres will get the proper price for it. But the small planter cannot do this, partly because he is always in debt and must sell as soon as possible; and it is this state of affairs which has given the strongest handle for the development of the Co-operatives, whose first claim is that every bale sold by the planter to them is properly graded and stapled, is lotted with similar cotton and is sold in the best market available.

It is of course only fair to say that the crux of the problem is the enormous size of the American Belt. Cotton grading is a very highly skilled occupation, and those who possess that skill must be well paid. To station a skilled grader in every small town in the Belt is not practicable, especially as his services would only be required for a few months in the year. The problem therefore can only be solved by some kind of government or co-operative action; and the American planters are not fond of government action and are very poor co-operators.

It is probably not going too far to say that in very few other countries is the primary marketing system quite as bad as it is in America. In India, where the area of the Cotton Belt is equally large and the planters still more primitive and economically weak, the government has done a great deal to help the marketing system and has even in some cases, *e.g.*, the Punjab, organized local markets through the agricultural officials which have been of great assistance, especially in helping to establish new varieties of cotton. In Egypt also the government has made many efforts to help the fellah. In the Sudan grading and marketing is entirely in the hands of the government. In West Africa the B.C.G.A., practically bought the whole crop at fixed prices, which were always as favourable as possible to the native grower. In Uganda marketing is also under a certain amount of government supervision. In South Africa again the grading is largely in the hands of the government. In the West Indies the B.C.G.A., have done a great deal to help the growers of Sea Island cotton, though the problem there is extremely difficult owing to the fact that the islands are so scattered and communications so poor. As to foreign countries, in Peru the industry is mostly under the control of large British firms, but in other Latin-American countries the marketing conditions leave a great deal to be desired.

Between the primary markets and the final Spot markets, such as Liverpool, there is of course a long way for the cotton to travel, but it may be said briefly that that part of the business is on the whole very well handled and with a minimum of cost in the way of middlemen's charges. In Egypt for example many of the exporting houses are branches of, or are closely connected with the merchanting houses in Liverpool or on the Continent, and such houses have now extended their interests to new countries like Uganda, and have long been established in Peru. The main cost is freight, and except for the many up-country districts in Africa where the cotton has a long land journey to the sea, the total expenditure on transport is relatively not very heavy. The ginning and baling charges are of course incurred at the very outset of the whole process of marketing. In many countries, as in America, it is done at the charge of the planter before he sells the cotton. In others such as West Africa the planter sells his cotton in the seed; and the buyer, who in those cases generally owns the ginnery, gins and bales the cotton. It may be added that in these cases the baling is generally much more satisfactorily done, for the baling of the crop in America is one of the worst features of the whole system of handling the crop.—*To be continued.*

THE SUGAR PROBLEM.

[*The following article has been abstracted from the Economist, Vol. CXII, No.* 4559 *and Vol. CXII, No.* 4560.]

I. The Chadbourne Plan.

THE Brussels Conference of December 9th-16th, like its numerous predecessors, failed to reach final agreement; yet it marks the furthest stage so far attained in the attempts of sugar producers to come to some arrangement for the international control of production and export. The following table, compiled on the basis of the official statistics published by the International Institute of Agriculture, gives some idea of the relative importance of the groups represented at the Conference and at the same time of the development of world production in the last five years.

Production.

MILLION METRIC TONS.

	World.	*Cuba.*	*U.S. Producers.*	*Java.*	*European Producers Represented.*
1925-26	25.2	5.0	2.7	2.3	4.2
1926-27	24.0	4.6	2.9	2.0	3.7
1927-28	25.7	4.1	3.4	2.4	4.1
1928-29	27.6	5.2	3.3	2.9	4.2
1929-30	27.4	4.7	3.6	2.9	4.3
Average 5 years	26.0	4.7	3.2	2.5	4.1

On September 30th, 1930 sugar prices reached the lowest level ever recorded, with the quotation for Cuban raw sugars *c.i.f.*, New York, at 0.94 cent per lb. The decline in world consumption of sugar in 1929-30 had accentuated the nervousness of buyers, and on the eve of the Brussels Conference a still further disquieting feature appeared in the shape of unexpected increases in the European crop estimates. Thus there was a greater stimulus to joint action on the part of producers than had hitherto been experienced.

As a first result of the critical situation, American interests in Cuba were forced into more whole-hearted support of control than ever before, and for the first time a scheme emerged in which control in Cuba had really strong financial backing. The so-called Chadbourne Committee included representatives of the great American banking interests in Cuba, and with this financial backing the lack of which had been the weakness of all previous Cuban attempts at control, Cuba eventually completed an agreement with the producers within the United States tariff wall, namely, United States beet-sugar producers, Hawaii, the Philippines, Porto Rico, and Louisiana. Cuba agreed to limit its exports to the United States to 2.8 million tons in 1931—a sacrifice of about half a million tons on its average export to that country in recent years—increasing this quota in the following two years by an amount equivalent to the increase in United States consumption, and in 1934 and 1935 (the last two years of the agreement) sharing the increase in the United States demand with the United States producers. The United States producers, on the other hand, agreed to limit their output to the 1929-30 level, with the above-mentioned proviso, regarding the years 1934 and 1935. As regards sugar to be marketed elsewhere than in the United States, Cuba then came forward with the offer, backed by Presidential decree, to control through a National Sugar Export Corporation 1½ million tons annually during the five-year period, to be purchased from the Cuban producers at $4 a bag. The required funds were to be obtained by a bond issue of $40 millions, and the interest and other charges to be refunded to the Government by an additional tax of 11 cents a bag for the next ten years.

Having in this way stabilised the position in their chief market, the United States—which has absorbed in recent years about three-quarters of Cuba's total output—having more effective financial backing than ever before, and having the 1½ million tons a year under their control for export to other lands than the United States as a powerful weapon in negotiations, the Cuban interests could cross the Atlantic with a greater degree of confidence than any of their predecessors. Java's attitude was, as on previous occasions, the relatively unknown factor. Her previous reluctance to join in any international agreement for restriction had been due to the fact that owing to its very low cost of labour, combined with favourable soil and climatic conditions and high development of research in field and factory, Java's costs are the lowest in the world, being generally estimated at about 8s. per cwt. for by far the greatest part of its output. Added to these advantages is proximity to the great markets of the East. On the other hand, the V. I. S. P. (United Java Sugar Producers) has recently been experiencing previously unheard-of difficulties in marketing its sugar; and the state of unrest in Eastern markets, combined with the growth of production in Japanese territories, has made conditions there less favourable, while in India the competition of European beet-sugar has recently been accentuated. The possibility, too, of the Cuban industry being in a considerably stronger position, and perhaps dumping part of its surplus in Far Eastern markets, was not to be disregarded.

At the preliminary meeting in Amsterdam the V. I. S. P. agreed to restrict its export by 20.7 per cent. in return for Cuba's promise to restrict production by 23.5 per cent. While Java's restriction is nominally one of export, it is in fact, one of production, since it is difficult to store sugar in the island owing to climatic conditions and to lack of storage space. According to the agreement, Java's 1930-31 export would be limited to 2.2 million tons of the new crop plus 0.1 million of its stocks (*i.e.*, one-fifth of the existing stocks). The Javans asked and obtained the right to increase their export by 100,000 tons

annually, claiming that this was warranted by prospective increase in demand in the Far East. In the case of both Cuba and Java the restricted production would be about 60 per cent. of the respective totals of available supplies.

Having thus agreed, the two great cane-sugar exporters went to Brussels with the request that the five European countries with a net export—Czechoslovakia, Poland, Germany, Hungary and Belgium—should limit their combined net export to 1.2 million tons, which amounts to 55 per cent. of the total available for export from these countries. The unexpected growth in the estimates of European production had brought the estimated total available for export in 1930-31 up to the level of 2.2 million tons, as compared with an actual net export of 1.4 million tons in 1929-30. Germany, with an estimated increase of 23 per cent. on last season's crop, became the protagonist for an agreed rise in the total European quota. This proved, however, impracticable, especially in view of the strenuous opposition of Java. The non-European producers had proposed that the 1.2 million tons European quota should be divided according to the 1929-30 export of the five countries concerned, Germany, under this arrangement, being entitled to 200,000 tons, but Germany now claimed a 450,000 tons quota for the first year of the agreement, to be reduced to 350,000 tons in the remaining four years. Her refusal to accept the 300,000 tons offered as a compromise led to the breakdown of the conference. Mr. Chadbourne, however, continued negotiations with Germany and these eventually proved successful.

The following table may throw some light on the attitudes taken by the various European producers at the conference:—

	Czechoslovakia	Poland	Germany	Hungary	Belgium
Per cent. of combined export in 1929-30 ..	48	26	16	7	3
Per cent. of combined surplus available for export, 1930-31	35	20	37	5	3
Per cent. of proposed quota to surplus available for export, 1930-31 ..	78	74.5	25	77	48
Per cent. of allocated quota to surplus available for export, 1930-31 ..	78	74.8	25*	80	43

If the proportions of the different countries in the combined export of last season, which were taken as a basis by the conference, are compared with the respective proportions in the probable total amount available for export this season, the relatively unfavourable position in which Germany finds herself this year is at once obvious, and her resistance to the quota of 200,000 tons offered becomes more comprehensible. On the other hand, the German sugar producers are able to sell a relatively large proportion of their production in the protected home market as compared with the other two great beet producers, Czechoslovakia and Poland. The German representatives were hampered by the circumstance that the renewal of their national agreement had not been negotiated, so that they had not the necessary mandate for entering into any contract.

Hungary and Poland made demands which were met in part by the sacrifice of 3,500 tons on the part of Belgium. The European quotas, as finally determined, were as follows;—Czechoslovakia, 590,000 tons; Poland, 320,000 tons; Hungary, 87,500 tons; Belgium, 31,500 tons; Germany, 500,000 tons for the first year, 350,000 tons for the second year and 300,000 tons for the next three years, making a total of 1,750,000 tons compared with her demand of 1,850,000 tons. The most important abstentions among exporters were the U.S.S.R. and some of the South American and Central American countries.

* Not accepted by, but reserved for Germany.

II. Prospects of the Plan.

The essential purpose of the Plan is to make room for the absorption of the present unprecedentedly huge carry-over by restricting further production or export during the coming five years. Last year's disconcerting relapse in the recovery of consumption and the unexpectedly large European beet crop in the current season have added to the difficulties of dealing with the stock situation. The problem, therefore, may be resolved into two main questions: first, whether it is possible to restore confidence in the market in the next few months; secondly, whether there is a possibility of the parties to the agreement pursuing a steady and united policy during the five-year period.

As for the coming months, with the assurance of a firm policy on the part of the conference members, a reversal of the recent downward trend of prices is not unlikely. The ratification of the agreement should restore to buyers a reasonable degree of confidence in the stability of the market, and there is a likelihood that invisible stocks will again be built up, absorbing a very considerable part of the present deadweight of "visibles," which is mainly responsible for the depression.

As regards the further success of the Plan, world conditions of sugar production and consumption in the next five years are not wholly unfavourable. On the side of production there is good ground for supposing that a natural pause in the upward trend has been reached. Cuba itself, for internal reasons, has little motive to extend the area under cane even in the absence of restriction, while increased unit yields are equally improbable within such a period. In Java a natural halt seems to have been reached in the

upward march of production, after the remarkable spurt of recent years (due to the spread of the high-yielding P.O.J. 2,878), as further increase of the area under cane is restricted by the Government in order to secure sufficient land for the production of food for the dense population. In Europe the beet lands have completed the process of recuperation from the War and its aftermath, while the encouragement of the beet-sugar industry by exaggerated protective tariffs has probably reached its limits. Such rise in price as might be expected from the putting into force of the scheme is not likely to stimulate new producers, and in any case the bringing of new cane areas into production is a comparatively lengthy process.

The strain of the plan is likely to come, not, indeed, from natural conditions of production, but from the mutual disagreements and distrusts of producers, both within the separate groups and between the groups. Meanwhile, in the face of a great common danger and the urgent need for action, unity is well within the bounds of probability in the coming months; the strain on loyalty will come as the danger recedes, with the restoration of an upward trend in prices. On the one hand are the usual difficulties of continued common action by groups of producers in very diverse circumstances, a difficulty that is peculiarly marked in the case of sugar, owing to the varying conditions of production and to the different parts it plays in the economy of the respective countries; on the other hand are the latent internal disagreements within the various groups. In the case of Europe, the initial struggles over quotas have already reflected some of these difficulties.

The internal position, however, of the two great cane-sugar exporters deserves further attention. In Cuba, restriction has never been a really popular idea, and under the Chadbourne Plan, as ratified by the Cuban Government, restriction depends on the consent of 65 per cent. of the producers. The mills, partly for economic reasons and partly, it would sometimes seem, for psychological reasons not entirely of economic origin, dislike limiting the amount of cane dealt with; the smaller mills, that is, those owned by native Cubans, which are already distinctly marginal producers, suffer most severely from the increase in costs as the scale of production is reduced. In the past, administrative difficulties in connection with the distribution of milling "contingents" have been very much in evidence. The scheme, too, means additions to the already high tax burdens. The colonos, or cane-farmers, dislike leaving their cane uncut, with consequent prolongation of exposure to the usual risks and steady diminution of sugar content; while the mills experience additional chemical difficulties in dealing with such cane when it is eventually cut. The agricultural labourers suffer hardship owing to the inevitable increase in unemployment which follows restriction. The Cuban Government itself has to steer a precarious course between increased control of the industry and the danger of adding fuel to the ever-latent unrest by increased unemployment and the awakening of anti-American elements of public opinion against a scheme engineered by American interests.

In Java the recent history of the V.I.S.P. shows, too, the danger of internal strain. Java producers have been reported to be still, on the whole, disinclined towards restrictive interference, having in the past, to some extent, tolerated the V.I.S.P. because of the strict limitation of its powers to co-operative selling of as much of the available surplus as possible at the best possible price. The introduction of a new policy of restrictive control of exports may, therefore, imperil the measure of agreement hitherto existing amongst its members. The holding back of sugar by the V.I.S.P. means also additional risks and costs of warehousing and associated charges that may be unpopular with members, and in addition, though the V.I.S.P. controls 90 per cent. of the output, the opportunity given by a waiting policy to the remaining 10 per cent. to skim the market when the chance arises is an additional strain on loyalty. Finally, there is the danger of friction with the exporting firms, on whose specialised knowledge of the complexities of Eastern markets the V. I. S. P. relies and who take much of the commercial risk at the present time. In the background lies the well-founded belief that the conditions of production of Javan sugar give the industry there a sounder basis than in any other country in the world and that, with its exceptionally low cost of production, it might even now weather the storm that would utterly destroy a more or less considerable proportion of producers in other countries.

Now, therefore, that the negotiations with Germany have been successful and the ratification of the Chadbourne Plan in February may be expected, the unfolding of a new chapter in the history of attempts at restrictive control will be awaited with interest, not unmixed with scepticism. The critical period for such an agreement among sugar producers will not be in the coming months, for the prospects of success in the very near future are good, but the subsequent phase, when the results of initial success are beginning to be felt and the danger of an immediate collapse of the market is past.

SUPPLEMENTS.

The following Supplements to the Journal can be obtained on application to the Editor:

1927 Sugar Supplement	..	1*s.*
Sugar Cost Accounts	..G. C. Skinner	1*s.*
Wilt Diseases of Coconut Palms.—(Parts I and II)	H. R. Briton-Jones	6*d.* each.
Giant Moth Borer of Sugar-Cane.. ..	..H. Martyn Skinner	6*d.*

ENTOMOLOGY IN THE TROPICS.

Some Entomological Experiences in the Tropics.

By C. B. Williams, sc.d.,
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The West Indies and South America.

My first introduction to the tropics was in March of 1915. I had been for the previous few months travelling in the U.S.A. as a holder of a Carnegie Entomological Studentship, but after five months of winter conditions I prevailed upon those in authority to allow me to visit the West Indies. The steamer I took allowed me a few hours ashore at most of the Lesser Antilles from St. Thomas to St. Lucia and I finished up with a week in Barbados and a week in Trinidad. In the latter island I made my first acquaintance with the notorious sugar-cane froghopper.

Almost exactly a year later, on 22nd March, 1916, I landed once more in Trinidad, this time not as a tourist, but to undertake investigations into the same froghopper, and particularly with instructions to try and find, somewhere outside Trinidad, a parasite that could be introduced with some hope of being a useful control.

The results of my five years work on the insect is available in my "Report on the Froghopper Blight" (Memoir No. 1, Dept. of Agriculture of Trinidad, 1921) and so much has been done in the past few years that much of it is now merely past history. I found only one new egg parasite—a *Chalcid* of the genus *Anagrus* in Costa Rica, but failed to get it in any numbers so that an attempt at introduction might be made.

The most interesting general result of my journeyings between Dutch Guiana and Costa Rica, and my studies of specimens from further afield, was to show that the froghoppers of the genus *Tomaspis*, or at least the grass-feeding species to which I paid most attention, have a very limited distribution. Every few hundred miles along the coast a new species appeared and the old one dropped out. In British Guiana round the mouth of the Demerara River there is *T. flavilatera*; in the North-west District of British Guiana a species which is, I believe, still undescribed although it has been referred to in print as *T. bodkini*; in Trinidad *T. saccharina*; in Tobago *T. carmodyi* (very close to *T. bodkini*). At La Guayra in Venezuela I found *T. propinqua*; at Porto Colombia and Colon *T. lepidon* and at the latter locality *T. reducta* in addition, while at Bocas del Toro, about 170 miles further along the Panamanian coast, and in the adjacent portion of Costa Rica there were two or three species including *T. modesta* and some undescribed. Specimens from British Honduras and Mexico which I examined showed that in each of these localities still different species occurred.

In direct contradistinction to the above series of froghopper species showing such limited distribution, these parasites showed an unusually large range. The Syrphid (*Salpingogaster nigra*) I found from British Guiana to Costa Rica and other collections showed that it extended from Brazil to Mexico, while the Vermilion Egg Parasite (*Oligosita giraulti*) was also shown to extend from British Guiana to Costa Rica. The *Anagrus sp.* that I found in Costa Rica had not at that time been recorded as a parasite of froghopper eggs, but quite recently an *Anagrus* has been found in these eggs in Trinidad, and I should not be surprised if it turned out to be the same species. The only two specimens that I obtained were sent to London, but so far as I am aware they have never been described.

In my report I said little as to the methods of work I adopted, so perhaps some notes on these might be interesting. When searching for egg parasites in a new district I made very little attempt to find actual eggs of the froghopper in the field. I used instead the following indirect method. First a search was made for localities which appeared to be suitable for grass-feeding froghoppers, and by sweeping with a sweep-net it was usually possible to find out quite rapidly whether or not froghoppers were present. The value of the sweep-net in searching for froghoppers was particularly shown in the island of Grenada where I made a rapid survey of the southern part of the island, by hanging out over the side of a running motor car and sweeping the grass along the sides of the roads as we passed. In this way I picked up specimens every few miles and established the presence of *T. saccharina* over an area that it would have been impossible to survey in the time available by any other means.

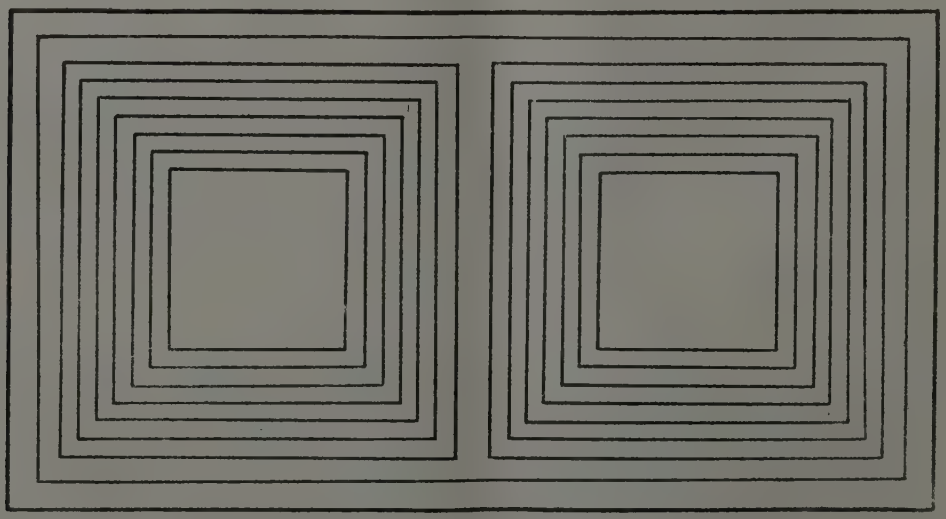
If the area examined was found to contain froghoppers and to be otherwise suitable for investigations two steps were taken. In the first place as many as possible of the froghoppers were collected alive and put in cages (usually of the hurricane-lamp-chimney type) with material for egg-laying. Practically always eggs were obtained in abundance in this way. In the second place a large quantity of grass, especially the base of the stems and surface roots, was collected and placed in parasite boxes which were sealed and light tight except for certain openings into which glass tubes could be fixed.

Within a day or two by this method there was on the one hand a supply of froghopper eggs and on the other large numbers of small parasitic insects which were emerging into the parasite tubes. The latter were examined and any likely insects among them were let loose in large glass tubes with a supply of froghopper eggs. Finally the bulk of the material from the parasite tubes was liberated in larger cages with more eggs, in case any possible parasite had been overlooked. Later the eggs were removed and kept under

observation for parasitic emergence. It was in this way the *Anagrus* emerged from two eggs that had been submitted to parasites some weeks before.

The parasite boxes that I used might also be worth some further description. They were stout wooden boxes, made locally in Trinidad from "Cyp" wood, and for convenience of travelling they were to nest one inside the other. The largest outside box was 28 x 14 x 14 inches externally. Within this was a slightly smaller box of similar shape. Inside the second box were two others side by side, each almost cubical and slightly less than one foot each way. Inside each of these there were nested six other boxes each slightly smaller than the other, the smallest being about five inches in each direction (*see* diagram). Thus each complete set consisted of 16 boxes; two large oblong and 14 cubical. The inner boxes were made of three-eighths-inch wood, but the outermost box was much stronger and ultimately had to be strengthened by metal angle plates to stand the knocking about that it received in travelling. Each complete set weighed just over 50 pounds and I had two sets made giving me 32 boxes in all. For travelling they appeared as two rope bound boxes, while when spread out they made a most useful and almost formidable array. They worked excellently and the only difficulty that I recollect having with them was to explain to foreign customs officials my reasons for carrying about such a supply of empty boxes.

While on the subject of froghopper parasites I should like to draw attention to a problem in this connection that still remains unsolved. While in Panama I found in froth masses of a froghopper in cocoa (*Clastoptera theobromiae*) small dipterous larvae which proved to be a species of *Drosophila*. I never saw any signs that the *Drosophila* larva was in any way injurious to the *Clastoptera* and I came to the conclusion that it was living as a commensal in the froth. The opinion was confirmed when I sent specimens to London and I was informed that the chances were "a million to one" against it being parasitic. On my return to Trinidad however I found a similar *Drosophila* in the froth of a *Clastoptera* which was common on casuarina trees in various parts of the island and particularly in and near St. Joseph Railway Station. In this case the *Drosophila* larvae were frequently found with their heads buried between the abdominal plates of the froghopper nymphs and firmly attached to them. Some observations that I made on specimens on small casuarina trees in pots seemed to indicate that the nymphs to which the larvae were attached gradually died, but I was not able to prove it beyond doubt to my own satisfaction. The Trinidad *Drosophila* has been described as *D. paradoxa* by Lamb (*Bull. Ent. Res.*, IX (1918), p. 157). As long ago as 1906 Ainslee had recorded (*Canadian Ent.* XXXVIII, p. 44) a *Drosophila* in froghopper froth in Minnesota, while in 1920 Baerg (*Ent. News*, XXXI, p. 20) again reported their presence in U.S.A., but stated they did no damage to the nymph beyond irritating and bruising the sides of the abdomen to which they were attached. Bonamour (*Bull. Soc. Ent.* France, 1921, p. 217) describes a *Drosophila* as parasitic on caterpillars of the butterfly *Pieris brassicae*, and I have seen a reference to one parasitic on spiders but cannot now locate it. In East Africa in 1927 I again found *Drosophila* larvae in froth of a species of *Clastoptera*, but did not have an opportunity for closer investigation. There is no doubt that the whole question of possible parasitism in *Drosophila* requires further investigation.



Arrangement of Parasite Boxes.

EGYPT.

In 1921 I went to Egypt and for the first 18 months, with some interruptions, I was engaged in investigating pests of cotton at the Laboratories of the Cotton Research Board. All other problems were overshadowed by the "Pink Boll-Worm" which had been introduced into Egypt about 15 years previously and was by this time costing the country somewhere between five and ten million sterling per annum.

Before my arrival excellent methods had been developed to deal with the destruction of the larvae which were carried to the ginneries in the seed, and also close seasons had been established (against this and another boll-worm) when no cotton could be grown. But there was still an enormous carry-over from one season to the next in the field owing to the development of a resting stage or diapause in the full fed larva as winter approached. In a small cocoon, usually but not always between two cotton seeds, the full fed caterpillar was capable of lying over from autumn till the following summer, and even in some circumstances till the next year but one.

It was obvious that one of the key-points in the understanding of this pest lay in this resting stage, which in many other parts of the insect's range is never developed, and I started an investigation of the relation of the diapause to climate and agricultural conditions. Laboratory facilities were excellent and money was available for any reasonable apparatus or experiment, but the work was continually interrupted by the necessity of undertaking administration, and after less than 18 months, when some progress was in sight, the Director of the Section resigned and I was taken away from research to act in his place. Work on the Pink Boll-Worm was carried on by one of my assistants, Ibrahim Effendi Bishara, and one of the more interesting lines of investigations taken up later was the possible influence of ratoon cotton on the prevalence and life cycle of the insect.

A few months before I left Egypt I received word from Mr. T. W. Kirkpatrick, who had been with me for some years in Egypt but had recently gone to East Africa, that he had discovered a Braconid parasite of the Pink Boll Worm on the Kenya Coast. The climate and agricultural conditions were very different in Kenya from those prevailing in Egypt and I felt that the possibility of establishing in Egypt an insect used to moist tropical conditions was small. Still I recommended to the Government that a man should be sent immediately to Kenya to collect some of the parasites, on the basis that the enormous annual loss from the Pink Boll-Worm justified the expenditure of a few thousand pounds so long as there was the slightest chance of success, however small. In fact the total cost of the experiment would be below one tenth of one per cent. of the annual loss. My proposals were accepted and in December, 1927, a few months after I left Egypt, Mr. Alfieri was sent to Kenya and succeeded in getting several shipments of parasites alive to Suez. According to the most recent reports I have seen from Egypt the Braconid has succeeded in establishing itself, but it is too early to say if it will be of any practical value.

Another most interesting pest in Egypt was the "Greasy Cut-Worm" (*Agrotis ypsilon*) which was a constant source of damage to young wheat in the autumn and to young cotton in the spring. The caterpillar, like many others of its tribe, cuts off the young growing plant at the ground level and thus does damage out of all proportion to the amount actually eaten. Two of the most important points to be solved in its biology were first the number of broods during the winter, and secondly where it spent the summer. Damage was negligible between April and September, and it was apparently almost impossible to find a single individual in any stage during this period.

A long series of regular observations with bait traps at different localities established the fact that there were three broods during the winter over the greater part of the country; the broods being more rapid in Upper Egypt than in the Delta. The largest brood of moths occurred about April and dissections showed that these were all sexually immature. A week or two later not one was to be found. The problem as to what happened to them was gradually solved with the help of a certain amount of luck in some observations, by the discovery that they migrate from Egypt in the spring and almost certainly go to Europe. Only in the extreme north of Egypt, near the coast where the summer temperatures are quite low, can the insect remain in the country from one winter to the next.

As in the case of many other migrant insects we were not able to determine from where came the individuals which repopulate the country in the autumn. Whether they come back from Europe, or are survivors in North Egypt at the end of the summer we do not yet know.

The knowledge that the insect was a migrant altered many of our ideas about control, as we then realised that the destruction of thousands of moths in bait traps or light traps in the spring, which was easy to accomplish, had little if any effect, as none of them were likely to lay eggs in Egypt. In fact the numbers of insects present in Egypt in the autumn probably depends on summer conditions in some other part of the world.

Still another of our major problems in this country was the control of scale insects on citrus trees. About the year 1913 Dr. Gough, my predecessor as Director of the Entomological Section, introduced the method of fumigating the trees with Hydrocyanic Acid Gas, and the number so treated has steadily risen from a few thousands in the early years to over one million per annum just recently. The questions requiring investigation were chiefly along two lines. First the best and cheapest method of producing the gas for fumigation, and secondly the causes, and the prevention, of the occasional serious injury to the trees.

In the first problem there were at the time four methods available. (1) The so called "pot" method of producing the gas in the field from Sulphuric Acid and Sodium Cyanide; (2) the use of liquid H.C.N.; (3) a German process known as "Zyklon" in which the gas is liberated in the field from tins in which it has been absorbed by a calcined absorbant earth; and (4) the use of Calcium Cyanide. After one of our fumigation entomologists had paid a visit to the U.S.A. to report on the use of liquid H.C.N. we decided that it was unsafe under Egyptian conditions. It was a much more difficult thing to determine the relative merits of the other methods; initial cost, speed of work, safety, reliability of results, rate of depreciation, accessories required, labour required, and cost of transport had all to be taken into consideration. During my last winter in Egypt we had several fumigation gangs working with each of the three processes. The pot method was the cheapest in initial cost of the gas, but was slower, required more accessories and labour, and higher transport costs and on a final balance sheet was more expensive per tree than the other methods, but at the time I left we had come to no final decision as to the relative position of the other two processes.

Thousands of trees were fumigated every night during the winter months by as many as thirty different brigades, and almost always without the slightest injury. Sometimes, however, for no apparent reason, some of the trees would be severely scorched. Although the proportion was less than 0.1 per cent. of the whole work it might happen that a large number would be damaged in one garden, or on one man's land, and one could not expect the owner to be pleased. Sometimes indeed he was vindictive! It was known that fumigation was more likely to produce scorching if the temperature was high; if the sun had been shining on the trees shortly before fumigation; if the trees were wet with dew; or if they had recently been irrigated. As however Egypt is a sunny country even in the winter, with frequent warm days, and as (contrary to the usual belief) the Nile Delta is decidedly a damp place at night in the winter nights, we were between the devil and the deep sea. If we started fumigation too early in the afternoon we took the risk of high temperatures and sunlight. If we started late and went on late at night we took the risk of dew, which often fell as early as 7 p.m. If (as we did in one year owing to external pressure) we took no risks, the whole campaign was disorganised, as it was impossible to say how many hours each day a brigade would work, and so we could not plan ahead any transport or make arrangements with any new gardens.

The annoyed owner of the scorched trees usually tried to argue that the damage was caused in his garden by carelessness in the measuring of chemicals. While there is no reason to suppose that this did not occur occasionally, double checks were kept on the consumption of all chemicals, and the measurements of all trees were recorded, so that any large error in one direction could easily have been spotted. Further, on several occasions we gave the trees double and once treble the normal dose as an experiment, without producing any signs of scorching. I well recollect one particular garden in which heavy burning occurred two years in succession and how impossible it seemed to find any reason for it. In the second year all the trees fumigated on one shift about 3.45 p.m. were badly scorched; all the trees in the next shift about 4.30 p.m. were uninjured, while in the following shift about 5.15 p.m. heavy injury again occurred. Even the owner on this occasion agreed that it was unlikely to have been the result of overdosing by the carelessness of the head of the brigade.

East Africa.

In June, 1927, I left Egypt and went to the Amani Research Institute in East Africa, which was an old German Agricultural Station in North East Tanganyika and had just been reopened by the Colonial Office. Owing to unforeseen circumstances my stay in this part of the world was limited to a single tour of two years, the earlier part of which was largely spent in organisation and administration in the absence of the Director. However I was able later to devote most of my time to investigation and a few points are perhaps of general interest.

Shortly after I arrived I found that froghoppers closely related to the Trinidad sugar-cane insect were common in the grass at the station, particularly in the more low-lying part known as Sigi, at an altitude of about 1,500 feet. In the froth of several of these I found larvae of a predaceous Syrphid, two of which I bred to the adult stage. The fly was a broad bodied black and yellow insect, resembling the typical hover-flies of Britain and quite unlike the black Syrphid of Trinidad. It was identified by the Imperial Bureau of Entomology as *Asaricina ericetorum* F. var. *africana* Bezzi. *A. ericetorum* is known throughout Asia and Africa; the variety *africana* is quite possibly a distinct species and was described by Bezzi from two specimens, one from Durban, South Africa, and one from Meru, Kenya. Sir G. A. K. Marshall has kindly looked up the species for me in the collections at the Natural History Museum and states that there are specimens there from practically every part of Africa, from Natal to Abyssinia and the Sudan, and from Tanganyika across through Uganda to Nigeria and the Gold Coast.

The two larvae that I bred were found on 5th October, 1927. One pupated on 10th October and emerged on the 27th. The other pupated on the 16th and emerged on the 2nd November. The length of the pupal stage was in each case 17 days. The average temperature at Amani in October is about 18.5° C. (65°F.). To attempt to introduce the insect from East Africa to Trinidad would be a difficult piece of work at the present moment, owing to the length of the journey, but it might well be considered when the proposed air services to East Africa are in operation.

About nine months after I had arrived at Amani reports began to come through of an invasion of Kenya Colony by locusts, and in July 1928, when the first generation of local bred hoppers was doing serious damage, it was suggested that I should go to Kenya to investigate the biology of this pest. I spent about one month in Kenya on this trip and later in the same year I made another shorter visit to see egg-laying and hatching which I had missed on the first occasion. Shortly after my return to Amani in December, 1928 the locusts paid us the compliment of returning my call and invaded our experimental Station on several occasions in very large numbers and did severe damage to the plantations, although they did not lay any eggs in this district.

Several interesting points were looked into. We heard that in one district the planters were attempting to scare away the swarms of flyers by employing native boys to run up and down beating tin cans. It was obvious that two factors would be concerned in this—namely movement and sound—and it was decided to experiment on each of these alone. It was of course well known that any sudden movement, even without noise will frighten many locusts, but to our knowledge noise without movement had not been investigated.

A small tent was built with an umbrella and a large blanket, and within this I hid myself with the necessary apparatus. When the flying locusts were thick on the ground, and even on the walls and roof of the tent, I made various noises within such as firing a gun and beating tin cans, while the effect on the locusts was watched by an observer at some distance by means of field glasses. In no case did the locusts appear to take the slightest notice of the sounds. Within a foot of the end of the barrel of a twelve bore shot gun they did not even jump when it was fired. A powerful intermittent alarm clock was then put down in the middle of a swarm and the insects settled on the clock whether the bell was ringing or not.

Next the electric horn of a motor car was tried, and in this case a slight response was noticed, a few locusts flying into the air. Finally a somewhat ear-splitting noise was made by drawing a file rapidly along the teeth of a large handsaw. In this case the effect was instantaneous and striking, as more than half the locusts for about 20 yards in all directions rose into the air. There was no doubt that this was the kind of sound that they could perceive. The experiment was repeated many times to see if both sexes were affected, and this appeared to be the case. Finally plans were drawn up to obtain, while I was on leave in England, an electrical apparatus that would produce at will from a loud-speaker sounds of any frequency and any intensity. Unfortunately for the investigation the plans came to nothing as I did not return to East Africa after my first leave.

Another most interesting observation in connection with the locusts was the appearance at Amani, in February, 1929, of a large flight of locusts accompanied by tens of thousands of a large burrowing wasp (probably *Sphex aegyptiaeus*) which were preying on them. In the previous 18 months I had not seen a single specimen of this Sphex at Amani. The particular swarm arrived in the middle of one morning and within an hour every footpath, roadway, tennis court, or any spot where the ground was free of vegetation was covered with hundreds of these wasps burrowing away for dear life and as soon as their holes were completed, stocking them with paralised locusts. All that day and all the following morning the locusts and the Sphex remained with us and the slaughter continued. About lunch time on the second day, however, the locusts began to depart and by 2.30 p.m. there was neither Sphex nor living locust to be seen. All that remained were hundreds of unfinished burrows and dozens of paralised locusts lying by the way sides where they had been hurriedly abandoned when the instinct to move on had overcome both the locusts and their enemies. There is no doubt that the Sphex had developed a migratory habit, and was thus enabled to keep in touch with the migrating hoards of its host.

SOIL EROSION.

Mr. H. H. Bennett, of the Bureau of Soils, United States Department of Agriculture, read a paper at the First Inter-American Conference on Agriculture, Forestry, and Animal Industry in Washington. He said that "not less than 126,000,000 lb. of plant food are being washed out of the fields of America every year. Something like 17,500,000 acres of land that were formerly cultivated in this country have been destroyed by gullying or so severely washed that farmers cannot afford to attempt their cultivation or reclamation. This is enough land to support a nation. It exceeds the total area of arable land in Japan. An even vaster area of land has been injured by sheet erosion. This is a slower process of erosion, as distinguished from gullying, which removes the film of soil from entire fields whenever it rains enough for water to run downhill. Erosion operates chiefly on top soil, the most productive part of the land."

Mr. Bennett described some of the areas in various parts of the country where as much as 40 inches of soil have been lost through erosion since the land has been under cultivation. In some places the land has been washed away to the underlying rocks. Cropping schemes, construction of terraces, soil-saving dams, and vegetative obstructions are some of the means of reducing the evils of soil erosion.

In regions where some of the land-saving measures are already being tried, it has been found that both the quantity and quality of the crop have been improved. In the cotton crop, for instance, it was found that uneroded land—that is, land which had not lost its top soil—produced more lint cotton per acre, more seed, and the seed itself yielded more oil. Since cotton seed may be bought on the basis of oil content in the near future this last is considered an important discovery. — (*Empire Cotton Growing Review*, Vol. VIII, No. 1.)

BIOLOGICAL CONTROL.

II.—Noxious Weeds.

By A. D. Imms, D.Sc., F.R.S.
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The subject of the biological control of insect pests was discussed in a previous article (*Tropical Agriculture*, Vol. VIII, p. 98). The present contribution deals briefly with the application of the biological measures in controlling noxious plants. This phase of the problem is a very recent development, the first practical experiment being carried out in 1902. The biological control of noxious plants presents itself as a possibility in cases where alien weeds have invaded land to the extent of rendering it useless. So far as the subject can be envisaged at present, it is only in special instances where such weeds have resisted cultural, chemical or other methods of control, or where such methods are impracticable, that biological measures may prove to be an economic proposition. The only biological agencies that have so far afforded any promise in this connection are phytophagous insects. The principle involved is the introduction of suitable types of plant-feeding species, free from their natural parasites, which are known to affect a given noxious plant in its country of origin. We have abundant evidence that alien insects which have entered countries, unaccompanied by their natural parasites, can exercise an immense destructive effect on cultivated crops. There consequently appears to be no valid reason why, similarly, properly chosen species of insects, introduced free from their particular parasites, should not likewise exercise a destructive effect upon noxious weeds given a favourable environment for their colonisation. It is this principle that is fundamental in problems of the insect control of weeds.

There are very obvious dangers attending the introduction of phytophagous insects from one country into another. The possibility always has to be faced that the introduced species may resort to feeding upon cultivated plants in a new environment, and so render the remedy little better than the disease. The introduction, therefore, of such phytophagous insects, however promising the latter may seem to be, demands the strickest safe-guards and the most exhaustive preliminary experimentation before liberations are effected.

It needs to be borne in mind, as Dr. W. R. Thompson has pointed out, that, although insects entail an immense amount of destruction to economic plants, they rarely occasion sufficiently vital damage which will affect the survival of well established species to any marked degree. Measured in economic terms such damage frequently assumes vast proportions, but in the biological sense it is not necessarily of the same importance. Furthermore, the recuperative powers of plants are so great that they are much less liable to be killed outright as the result of insect attack than insects themselves, which almost always succumb from the effects of their parasites.

It will be obvious that, in any project of weed control involving the utilization of phytophagous insects, the latter necessarily require to be species known to be either monophagus or oligophagous in habit. Species that are either stem-borers, or destroy flowers or seeds, offer many advantages over mere defoliators. They are, for example, more specialized in habit and therefore less likely to become adapted to new plant-hosts in another environment. Also, species that check the multiplication and spread of a noxious plant are likely to produce more economic benefit than those which prey solely on the foliage.

The botanical affinities of the noxious plant it is desired to control is likewise a matter of great importance. With such plants as *Opuntia* the likelihood of insects which feed upon them resorting to other hosts is somewhat remote. Insects living on plants endowed with such acrid juices, along with other specialized physiological and structural features, exhibit so peculiar and rigid an adaptation to their particular mode of life, that they are unlikely to infest plants botanically only distantly related; and with entirely different physiological attributes. On the other hand, with plants of the natural order Rosaceae, for example, there is always a looming possibility that in a new environment insects, which normally feed upon a single species or genus of that order, will become pests of one or other of its numerous cultivated members.

It will be readily understood that, under the conditions demanded by noxious weed control, parasites assume an antagonistic rôle to the one they perform as agents in repressing insect pests. In other words, parasites require to be rigidly excluded in all cases where insects are utilized in the repression of weeds. The unforeseen or accidental entry of such agents, along with their phytophagous hosts, into a new and favourable environment, might well result in the biological control of the plant-feeding insects, and their utilization in any campaign of weed repression rendered of little value.

The control of Lantana.—The first attempt to control a noxious plant, by means of introducing specific insect enemies, was made in the Hawaiian Islands with reference to the alien weed *Lantana camara*. This plant is native to the warmer parts of America and was originally introduced into the Hawaiian Islands for ornamental purposes. The shrub ultimately spread to such an extent that it became a real scourge in the pastures of low lying regions, especially on the leeward side of the Islands. In 1902 an entomologist, A. Koebele, visited Mexico with a view to acquiring first hand acquaintance with the insect fauna of *Lantana* in its native habitat. As the result of his investigation 23 species of insects were transmitted to Honolulu and from among these eight kinds

were ultimately successfully established in the Islands. Each of the eight species attacks the plant in a somewhat different way and it seemed likely that their combined influence would exercise considerable check upon its growth and spread. Three species that have proved the most effective are the Tortricid moth *Crocidosema Lantana* Busck., the seed fly *Agromyza lantanae* Frogg., and the Tingid bug *Teleonemia lantanae* Dist. Larvae of the first mentioned insect bore into the flower stems and devour both flowers and young fruit: the *Agromyza* larvae attack the berries and the Tingid bug checks growth and blossoming by destroying the young foliage. Of the remaining five species of insects, two are larvae of *Thecla* butterflies which feed on the flowers and thus restrain the production of berries; two are moth larvae and the fifth is the Trypaneid gall-fly *Eutreta xanthochaeta* Ald. Individually, none of these five species appears to be of much importance, but collectively they are to be regarded as accessory agents in checking the plant. The net result of these insect introductions is that the spread of *Lantana* has been appreciably restrained. It no longer readily colonises lands once cleared and the labour of its eradication has been lightened. It has, however, been too readily concluded, by those unfamiliar with the true state of affairs, that entire control of the plant has been accomplished. This, as a matter of fact, is not the case and the colonisation of additional insect enemies is regarded as being necessary in order to try and secure more complete economic results.

Lantana is, likewise, a serious pest in other parts of the world. In Fiji it has become sufficiently troublesome and difficult to eradicate to cause the authorities there to turn to biological control methods. Certain of the *Lantana*-feeding insects have been introduced from Hawaii and it appears that the *Agromyzid* fly has already checked the spread of the plant to some extent. The two *Thecla* butterflies have also been introduced together with the Tingid bug *Teleonemia*. The control of the plant affords promise of becoming successful, but it is too early to forecast the results of the experiments.

Introductions of *Lantana*-feeding insects have also been made into Queensland and Mysore, but no satisfactory results have yet been recorded. It may be added that in several parts of the Indian Empire the spread of *Lantana* in the forests has become a serious problem since it is proving deleterious to natural regeneration.

The control of Prickly Pear.—The largest and most important campaign of biological control of noxious weeds concerns prickly pear (*Opuntia* spp.) in Australia. This pest is estimated to have taken possession of 60,000,000 acres of land in Queensland and New South Wales. In the main the affected areas comprise natural grazing land whose value is less than £3 an acre. Under such conditions chemical or cultural methods of control are not practical propositions, except where the infestations are relatively slight. In their native habitat in North and South America many species of *Opuntia* are known, yet none of them are serious menaces to agriculture. Of the few kinds introduced into Australia at least four are major or minor pests. In America, insects, diseases and other factors are responsible for keeping down prickly pear within reasonable bounds, whereas in Australia such natural controlling agencies are absent, and the spread of the plant has gone on unchecked.

The Prickly Pear Board of Australia has been engaged, for some years, with an attempt to bring about a condition of biological equilibrium, by the introduction of insects and other organisms likely to function as natural checks. Officers of that Board have covered widespread cactus areas in North and South America for the purpose of investigating insects affecting Opuntias in their natural surroundings. Extensive biological study is being carried out at the Station at Urvalde in Texas and, from here, likely species of insects are shipped to Australia. On arrival they are transferred to quarantine buildings at Sherwood near Brisbane, where breeding tests are carried out with respect to the possibility of any introduced species attacking crops or other useful plants. At the same time, safeguards are instituted against the accidental introduction of insect parasites. Finally, species that offer favourable potentialities are liberated at suitable centres, where they are left to colonise themselves. A number of species have now become acclimatised to Australian conditions and, among them, the moth *Cactoblastis cactorum*, whose larvae tunnel through the tissues, is probably the most important. The cochineal, *Dactylopius tomentosus*, has become distributed almost throughout the infested areas, and the plant bug, *Chelinidea tubulata*, now flourishes in countless millions in many localities. The red spider, *Tetranychus opuntiae*, also covers many thousands of square miles and is rapidly extending its range. Mr. A. P. Dodd in his 1929 Report on this problem, states that the established complex of insect enemies is already bringing about a considerable degree of control of this noxious pest. In the heart of the pear country it is now possible to travel for one hundred miles without seeing any healthy plants. The success attained by the introduction of the *Cactoblastis*, which is known to be very rapid and drastic in its effect upon the plants, has changed the outlook of the whole problem, and it is reasonable to expect that vast areas of pear will be eradicated within a few years. Unless anything untoward happens, or the beneficial insects become seriously checked by the activities of indigenous predators or parasites, the work of the Prickly Pear Board shows promise of ultimately solving the problem it is contending with.

Australia is by no means the only country that has become colonised by prickly pear. In Ceylon, for example, an extensive area of the Northern Province was formerly infested by *Opuntia monocantha* but was ultimately almost completely exterminated by the cochineal *Dactylopius indicus* which is stated to have come from Madras. According to F. P. Jepson, (*Tropical Agriculturist*, Vol. LXXV, 1930, p. 63) the cochineal insect has not maintained the same efficiency in controlling this species of prickly pear in the Southern Provinces. Another Opuntia, viz.: *O. dillenii* has become very prevalent in recent years in the Northern Province and it is believed to be an accidental introduction from Madras. *Dactylopius indicus* does not appear to be capable of exercising any controlling influence over this plant, a fact which led to the introduction in 1924 of *D. tomentosus* from Australia. According to Jepson the experiment has proved remarkably successful. A large area of scrub in the neighbourhood of Trincomalee was cleared by its agency in eighteen months. It has also given equally satisfactory results in other districts; land which was previously occupied by *Opuntia* scrub, 6-10 feet high, is now under cultivation.

In 1926-27 consignments of *Dactylopius tomentosus* were forwarded to Mysore and to Tuticorin with the object of endeavouring to control *Opuntia dillenii*. The insects have become established and it is stated that an area of 40,000 square miles is now covered by this species in southern Madras. Very large tracts of land have been cleared through its agency and land so liberated has now come under cultivation for the first time for many years. It is further claimed that the whole prickly pear area of 114,000 square miles offers prospects of being cleared by 1940, judging by the progress so far achieved. As Jepson remarks, if this forecast be fulfilled, the experiment promises to become a classic example of the control of weeds by biological methods.

Several species of Opuntia have become troublesome pests in Mauritius, notably *O. tuna* and *O. monocantha*. The introduction of *Dactylopius indicus* by d'Emmerez de Charmoy resulted in rapid destruction of *Opuntia monocantha*, and in his 1929 report on the subject, it is stated that within 15 years this plant has become completely controlled on the Island. The introduction of *D. tomentosus* from Ceylon, in an attempt to control *O. dillenii*, is a much more recent experiment. Its establishment has proved successful but the economic results of the experiment is a matter that future years can alone decide.

In Madagascar it appears that rather an anomalous state of affairs exists. R. Decary tells us that *Opuntia dillenii* was formerly prevalent in a wild state on uncultivated land and was an essential local fodder plant. Since 1924 the cochineal *Dactylopius coccus* entered Madagascar under accidental circumstances, it is believed, from the neighbouring Island of Reunion. The insect spread so rapidly under the prevailing conditions that, in about two years, the Opuntia was virtually destroyed and the cochineal insect itself became no longer evident. Decary has more recently suggested the introduction of some spineless species of Opuntia suitable to take the place of *O. dillenii* and which, at the same time, is resistant to the *Dactylopius*.

The control of Clidemia.—At the present time an experiment is being carried out in Fiji for the purpose of attempting to control the noxious shrub *Clidemia hirta*. Out in Trinidad the plant is not regarded as a pest, and is kept under restraint by a combination of various factors of which phytophagous insects are but one of them. Studies carried out in Trinidad showed that the Thrips, *Liothrips urichi*, is common on this plant throughout the Island. It apparently causes its host to become stunted and to flower less freely. It therefore appeared to be a suitable insect for introduction into Fiji, provided that it were proved to exhibit no tendency to attack plants of economic importance. In October 1929 W. H. Simmonds visited Trinidad and studied the Thrips on the spot. It was found to be attacked by a number of natural enemies which had to be excluded in any effort made to introduce the insect into Fiji. He was able to send a large consignment of the species to Suva, where a proportion of its individuals were released in the field in 1930, and the remainder kept for breeding further stock. It is obviously too early for any forecast of the possible success of the experiment to be made, and it remains to be seen whether the *Clidemia* alone will prove an efficient controlling agency.

Other weed control experiments.—In New Zealand an extensive campaign has been inaugurated more particularly with reference to the control of blackberry (*Rubus fruticosus*), ragwort (*Senecio jacobaea*) and gorse or furze (*Ulex europaeus*), all of which are immigrants from Europe. In the case of blackberry, studies are being made with special reference to the suitability of the stem-boring Buprestid beetle (*Coraebus rubi*) of Southern Europe. A promising enemy of gorse is the pod-infesting weevil (*Apion ulicis*), while the Hypsid moth, *Tyria jacobaea* is an important enemy of ragwort. The two latter species, it may be added, are very common in England. At first studies on these three species were carried out at the Rothamsted Experimental Station, which were responsible for sending out to New Zealand large numbers of the insects mentioned. At a later stage, this work was transferred to the Parasite Laboratory at Farnham Royal where it is being undertaken at present. Preliminary liberations of the *Tyria* and *Apion* have been made in New Zealand, but the campaign is not sufficiently advanced to give any indication

with regard to its outcome. In Australia the biological control of *Hypericum*, is an additional problem and, for the time being, attention is being mainly given to Chrysomelid beetles and Cecidomyid gall midges as possible agents for this purpose.

In the Hawaiian Islands the obnoxious tropical sedge, known as nutgrass (*Cyperus rotundatus*), is a troublesome pest plant which probably entered the territory about the roots of imported plants. Attempts to control this plant by the introduction of certain insects, that are associated with it in the Philippine Islands, have been made. The Tortricid, *Bactra truculenta*, is now well established but has not so far proved of much value in this respect: in some localities, it may be added, it suffers heavily from the attacks of indigenous parasites. In the same Islands Pamakani (*Eupatorium glandulosum*) and gorse have become troublesome immigrants; while the subject of their control by biological means has received consideration no campaign has so far been undertaken.

In concluding these remarks it may be added that the biological control of species of prickly pear has so far proved more successful than in the case of any other pest plants. The Opuntias appear to be particularly susceptible to the effects of insect injuries which, in their turn, open the way to subsequent bacterial and fungal infection. The combined effects of such agencies have proved to be sufficiently potent to result in the practical eradication of plants of this type, from several areas in different parts of the world. It appears likely that, in Opuntia-feeding insects, we have a most promising weapon destined to achieve far-reaching results in the future.

THE BIRD OF PARADISE.

Mr. P. L. Guppy states in an article which appeared in the *Avicultural Magazine*, Vol. IX, No. 1, that the idea of colonizing the Greater Bird of Paradise, *Paradisea Apoda*, in Little Tobago was conceived by Sir William Ingram who in 1909, through Mr. W. Frost, introduced 48 of these birds in the Island. Little Tobago, about 250 acres in extent, is well covered with vegetation and supplies abundant food for the birds in the form of berries, fruit and insects. In addition, bananas and pawpaws are also grown to supplement the natural food resources of the Island. Although the birds have often been seen since they were released all efforts to find their nests or eggs have failed. Owing to the caution and sagacity of the old males, attempts to snare the birds have also proved unsuccessful. Their favourite haunts appear to be the elevated ground on the sheltered well covered side of the Island where the timber trees are of more luxuriant growth.

G. G.

FROGHOPPER ECOLOGY.

Notes on the Ecology of *Tomaspis saccharina* Dist. (Homoptera, Cercopidae), in Trinidad.

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The sugar-cane froghopper, *Tomaspis saccharina* Dist., is a serious pest of sugar cultivations in Trinidad, in which it is able to complete its life history. Considerable information has been accumulated as to its ecological relations in the cane fields, but no specific study seems to have been devoted to discover its natural habitat or its conditions of life there.

In the cane fields, the froghopper is abundant throughout the rainy season, during which there are three generations, often with the addition of a less definite fourth brood. With the cessation of the rains, breeding stops and scarcely any nymphs or adults are to be found during the dry weather. The period (December to April or May) between successive rainy seasons is bridged over by the aestivating eggs (1).

The balance of evidence up to the present goes to show that *Tomaspis saccharina* is confined to Trinidad and Grenada, and it is almost certainly native in Trinidad (14, pp. 53-54; 5, p. 8). It is true that *Monecphora flavifascia* M. &. B. described from Cuba is stated to be " . . . very close if not identical with the dark form of *Monecphora saccharina* Dist. as illustrated by Williams " (8, p. 96), but in the absence of a comparison of specimens from the two localities, it is difficult to assign much significance to this statement. There is a strong probability, therefore, that *Tomaspis saccharina* is native to Trinidad and an examination of its native haunts accordingly becomes a matter of some importance.

Discussing the range of this species in Trinidad, Gough (1) writes: " . . . it occurs practically everywhere. It is found on grasses in the high woods far up the mountains, it is common on the grasses in the cacao plantations and occurs on grasses in coconut plantations at sea-level." Urich (11, p. 9) adds: "Grasses growing on damp clay soils appear to be preferred."

Withycombe (14, pp. 294-301) describes in a semi-popular paper, the probable course of the establishment of froghoppers in the cane fields. He suggests that froghoppers were originally common on "grasslands" where conditions were sufficiently moist, and were driven from them by the extension of cultivation, especially by the clearing of forest and bush. It seems probable that this author refers to grass growing under shade, and not to open grassland, thus regarding the original habitat of the species as forest. As will appear later, this is the conclusion derived in the present paper.

No mention appears ever to have been made as to the presence of froghoppers in, or their absence from, the natural lowland savannahs, of which there is an extensive belt in the north of Trinidad, running, with some intersections of low bush and of cultivation, from the Caroni Swamp on the west coast, to within six or seven miles of the east coast. These patches of dense bush are, indeed, quite typical of tropical American savannah (10, p. 370; 13, p. 295). Like the savannahs of the mainland, those of Trinidad are covered with a Xerophilous vegetation. Hardy (2, p. 250) gives a useful summary of these Trinidad savannahs and states that the surface soil consists of quartz sand containing little organic matter, with a heavier sub-soil showing signs of pan-formation underlying it. The sandy layer varies in depth from one to four feet. Hummocks on the surface are characteristic, and the flora includes such characteristic forms as the Cocorite palm (*Maximiliana*), a spiny palm (*Bactris major*), stunted Malphigiaceous shrubs (including *Banisteriopsis leptocarpa* and *Byrsonema verbascifolia*), a small *Heliconia*, a *Coccoloba*, together with coarse grasses and sedges. Grasses form the dominant part of the flora in the more open parts. During the wet season, the ground becomes waterlogged and it dries out almost to completion in the dry period.

In spite of careful search, froghoppers have never been found by the writer on savannahs, although there would appear to be abundance of food for them in the wet season, to be derived from the numerous grasses. When such lands are brought into cultivation, they are said to be highly subject to froghopper blight (2, *loc. cit.*), and since both cane fields and savannahs may be described as stretches of more or less open country, supporting a dominant grass flora, they might both be expected to be equally favourable to froghoppers. It has been shown elsewhere, however, that the magnitude of a froghopper population is closely bound up with soil characters (9). Experiments by Hardy (3) further indicate that a sandy soil is the least suitable type of all for oviposition, and it is possible that oviposition never occurs in a soil with a moisture content considerably above or below the sticky point (4). On the savannahs, as has been shown, the soil is either waterlogged or dried out for most of the year, so that the period during which oviposition can take place is of very short duration, and in addition, the soil appears to be of a fundamentally unsuitable type. These facts would thus appear to furnish a complete explanation of the absence of froghoppers from the Trinidad savannahs.

As shown above, froghoppers are known to occur in forests and in moist, shaded cultivations; Withycombe has already contemplated the possibility of their origin in such localities, and the possibility of the froghopper being a forest insect therefore remains for consideration here. It should be pointed out, however, that *Tomaspis saccharina* is not at all common in mountain rain-forest, and that the common froghopper of the cacao cultivations is another species, *Tomaspis pubescens*. In forests, there is humidity sufficient to enable froghopper breeding to proceed throughout the year, without the dry season check which occurs in the cane fields, and the chief limit to froghopper abundance seems to be the availability of food supply, as grasses do not grow to any extent under the dense shade of rain-forest, but only where the shade is slightly reduced by a natural or an artificial clearing.

It seems probable that the conditions in a cane field with a standing crop are more comparable with those in a sparse forest than with the conditions in a savannah during the wet season. The leafy plants throw a fairly dense ground shade from a canopy some distance above ground, and waterlogging is deliberately alleviated by agricultural practice. Since, moreover, the shade producing plants are themselves grasses, there is an almost unlimited food supply for the froghoppers, which can therefore increase at a very rapid rate. It is only when the canes are cut in the dry season that savannah conditions supervene. *Tomaspis saccharina* can survive the dry season by virtue of the power of aestivation possessed by its eggs. This power of aestivation does not appear to be shared by the eggs of *Tomaspis pubescens*, and this fact probably explains why the former species has been able to adapt itself to cane field conditions while the latter has not.

The history of the rise of *Tomaspis saccharina* as a pest of sugar-cane seems to be somewhat as follows, although the argument is based at present rather upon the balance of probabilities than upon actual proof. It has been shown elsewhere that in the cane fields there is marked overlapping of successive broods, since the eggs of any one batch have an incubation period which varies considerably among the several individuals (12). In the forest, the succession of broods does not begin afresh each year as it does in the cane fields, since there is no appreciable check to breeding during the dry season. In consequence there is practically no distinction into broods at all, since overlapping has proceeded much further, and all stages of the froghopper can be found at all times. There is thus a ready availability of hosts for the natural enemies, and the activities of these, combined with the relative scarcity of food grasses, keep the insect within reasonable bounds.

As has been shown, the froghopper and its enemies find conditions in the cane fields during the wet season similar to those in the forest where they originated. With the advent of the dry season and the cane harvest, however, conditions are changed and the fields become so many dry savannahs for all practical purposes. Froghoppers and their enemies cease to breed, but the eggs of the froghopper, already laid in the soil, are able to remain viable and unhatched for a considerable time, until the first rains. When the wet season sets in once more, these

eggs hatch, and a froghopper population once more becomes evident, but at least some of the natural enemies have received a very severe check from the prolonged drought, and their numbers can only be replenished from those exceptional individuals which escape extinction. The froghopper thus has two important factors in its favour in the cane fields, viz.: abundant food supply and comparative freedom from natural enemies. It is probable that the first of these is the more important.

A certain amount of evidence confirming this view has been obtained. This may be considered under two heads, (1) the study of parasite and predator relations in the cane fields and (2), the ecological relations in an environment approximating to the supposed natural habitat.

The systematic study of parasites and predators of the froghopper in the cane fields was commenced in March, 1930, and is still proceeding. As a detailed account of this work is contemplated in the near future, only the general conclusions will be mentioned here. The most important natural enemies appear to be the predaceous larvae of a Syrphid fly (*Salpingogaster nigra* Schiner) which destroys nymphs, and a newly discovered egg parasite, *Anagrus*, sp. (*Hymenoptera, Mymaridae*), not yet identified. Although the proportion of eggs parasitised in the field by *Anagrus* has been recorded as high as 33 per cent., there is good reason to believe that this figure gives an erroneous idea of the state of affairs (9, p. 156), and the maximum figure which is reliable seems to lie at about 5 per cent., the usual percentage parasitism being below this. The occurrence of this species is also very erratic and the records show very great fluctuations in its abundance from month to month at the same station, and from station to station during the same month. Distribution seems to become most widespread towards the end of the year.

Detailed counts of the abundance of *Salpingogaster* larvae have confirmed the observations of the earlier workers (6) that this predator only becomes abundant in the later froghopper broods. During the dry season, they seem to be completely absent from the cane fields, they are very scarce during the first brood of froghoppers and become most abundant during the early part of the third brood. Later, their numbers are again reduced, some weeks before froghoppers cease to multiply. The value of the observations during the wet season of 1930 is reduced, however, by the fact that the rainfall was exceptionally low and erratic.

The writer was informed by Dr. J. G. Myers, that froghoppers of the two common species were abundant along an oil pipe-line running through virgin forest between Moruga and Guyaguayare, near the south coast of Trinidad. Accordingly, a visit was made to this area on the 9th November, 1930, with the special object of studying the conditions. A narrow passage, about eight feet wide, over a total distance of some twelve miles had been cleared through the forest for the conduct of the pipe. This operation had slightly reduced the forest shade over a narrow strip extending the whole distance of the clearing.

The first froghoppers were encountered about four hundred yards beyond the cultivated land at Moruga; nymphs of *T. pubescens* were found on an unknown grass, and of *T. saccharina* on *Axonopus compressus*. In the shade of the mixed forest through which the first part of the route lay, these grasses soon gave place to *Paspalum conjugatum*, which was almost the only grass for the rest of the traverse, and formed, in some places an almost continuous carpet, in others, a series of discontinuous patches. In the mixed forest, growing on a rather heavy clay soil, this grass supported a heavy population of *T. pubescens* and *T. saccharina*. The latter were found at soil level, the former on the leaves of the grass, often on the same plants. Examination of the spittle masses of *T. saccharina* at frequent intervals along the route showed that 4·7 per cent. were invaded by *Salpingogaster nigra*. This is considerably in excess of the value found in most cane fields during the same month (nil, except one estate with a mean incidence of 4.7 per cent.), and it is probable that even this figure is an under-estimate, since there was considerable likelihood of the inclusion of nymphs of *T. pubescens* in the counts, a species which is only exceptionally attacked by this syrphid.

Soil samples also were taken at intervals, and were found on examination in the laboratory to contain numerous eggs of *T. saccharina*; 10 per cent. of these were found to be parasitised by a species of *Anagrus*, apparently different from that found in the cane fields. This value again exceeds that recorded in the cane fields during the same month.

In two places, the mixed-forest gave place to extensive pure stands of Mora (*Dimorphandra mora*), and the clay soil at the same time was replaced by a sand, as is usual in such cases (6). In the first Mora strip, which alone could be examined in detail in the time available, no grasses at all were found over a distance of about a mile, except on two exposed river banks, where a few patches of *Panicum polygonatum* occurred, mixed with sedges. No froghoppers were found on these exposed banks. Further along, two patches of *Paspalum conjugatum* were encountered; the first of these was very sparse and contained no froghoppers; the second was rather denser, measuring fourteen by four yards. This contained fourteen nymphs of *T. pubescens* and six of *T. saccharina*. No syrphids were found here and a soil sample taken from this spot yielded no eggs. Further examination of this area is to be made during the dry season.

The observations made on this journey, when taken in conjunction with the cane field records, thus offer some confirmation of the hypothesis that *Tomaspis saccharina* was originally a forest species. The extreme scarcity of froghoppers on the

loose sandy soils of Mora forest also is of interest, conforming as it does the conclusion already derived by Hardy, that froghopper oviposition rarely occurs to any extent in loose sand. It may be added that Myers in an unpublished note on his journey over this route, undertaken some four weeks previously, states that he found only *T. pubescens* in the second Mora forest, *T. saccharina* being completely absent. The general conclusions to be derived from these observations are of considerable importance in a consideration of a suitable parasite for introduction to effect biological control.*

Summary.

1. The hypothesis is suggested that *Tomaspis saccharina* Dist. is a forest insect, which has become established in the cane fields of Trinidad by virtue of the power of aestivation possessed by its egg. Its presence in the cane fields relieves it to a large extent of the controlling effects of food shortage and of the chief natural enemies.

2. Confirmatory evidence of this is adduced from (*a*) the absence of froghoppers from the natural savannahs of Trinidad and (*b*), the presence of froghoppers in forest areas, one of which showed on examination that the abundance of natural enemies was probably significantly greater than in the cane fields at the same time of the year.

3. In a forest area, presumably approximating to a natural habitat, *Tomaspis saccharina* is more abundant on the clay soils of mixed forest than on the sandy soils of Mora forest, thus confirming earlier observations and experimental results.

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* Thus, Dr. Myers, to whom these observations were communicated, considers it unlikely that a parasite of a rain-forest froghopper could be suitable for this purpose. The parasite of a savannah froghopper, if one could be found, or failing this, of a monsoon forest froghopper, would be much more likely to succeed.

RUBBER IN 1930.

In their annual Review, *Messrs Symington and Sinclair* report the 1930 year as a difficult one for all connected with the Rubber trade and particularly so for Rubber producers who have been faced with a steady accumulation of surplus stock and a falling price. The year began with an average monthly price for Ribbed Smoked Sheet on the spot at 7.43*d.* which declined to 6.17*d.* in June, to 4.07*d.* in September and eventually closed at 4.48*d.* in December. Shipments for the year exceeded consumption by 138,500 tons or an average of about 11,500 tons per month. Stocks in the United Kingdom showed a steady rise at the end of each month, while in U.S.A. amounted at the end of 1930 to over 200,000 tons or practically double to what they were the year before. Arrangements with Dutch producers whereby a majority of European and native owned estates ceased tapping for the month of May failed to improve the situation.

With increasing evidence that consumption was declining, efforts were made to bring about some measures of compulsory restriction under the auspices of the British and Dutch Governments. After protracted negotiations with regard to a scheme by which it was understood that a reduction of about 25 per cent. in output was aimed, the Dutch East Indies Government found themselves unable to participate, mainly on the grounds that they did not wish to control native output. Their decision brought a rapid fall in the Spot price which reached its lowest point for the year at $3\frac{9}{16}$*d.* on 1st October. During this month, however, with the hope that the Dutch Government might reconsider its decision, with rumours that the French Government proposed to put a duty on all rubber except that produced in their colonies, and with indications that various producing companies were contemplating to reduce output, the price of rubber rose to $4\frac{13}{16}$*d.* This rise was unfortunate in that it retarded arrangements made to reduce output while it encouraged tapping by native producers. Shipments, although reduced, have thus remained well above the level of the world's requirements.

G. G.

TROPICAL WORLD NOTES.

Grenada.

The Government of Grenada has appointed a Commission to report on the conditions under which the local spice industry is carried on; to ascertain the reasons for the fluctuation in the world prices of nutmegs and mace, and state the economic price for these commodities in Grenada; and to advise what steps, if any, may be taken by the Government for the furtherance of the local spice industry.

At a meeting of the Agricultural Association of Grenada the Administrator, Mr. H. R. R. Blood, spoke on what the Government might be prepared to do by way of assisting producers of marketable crops. The Governor, he said, was endeavouring to create internal security to enable agriculture to work out its own salvation. Internal security included means of transportation, so that growers would be able to get their products to the nearest market. Roads were being constructed. It was necessary to find new markets abroad for the products of Grenada, and the Government had decided to carry out certain experiments in the preparation and marketing of fruits and vegetables.

Co-operation on the part of growers was essential; when the co-operative movement had reached a stage which would give it a claim to legal status the Government would be willing to give the necessary help. Agricultural experiments to be undertaken by the Government would include coconut growing. The Spice Growers' Association had been informed by the Government that if it could control 60 per cent. of the spices grown in the Colony the State would consider the advisability of organizing a credit bank to finance small producers.—(*Times Trade & Engineering Supp.*)

* * *

Gold Coast.

According to Colonial Report No. 1504 the world wide depression in trade was reflected during 1929 in the Gold Coast, where the total value of external trade was £22,760,097 as compared with £26,024,920 in the previous year. Imports decreased in value by £2,117,664 and exports by £1,147,159. This abnormal decline was mainly attributable to the fall in the price of cacao which affected not only the export but also the import trade by reducing considerably the purchasing power of the people. The average f.o.b. value of cacao per ton, which in 1928 was £50, fell to £41 in 1929, with the result that the total value of cacao exported decreased by £1,525,019.

Although the situation has caused some anxiety it must nevertheless be realised that during the period under review the prices of raw materials dropped considerably throughout the world; and notwithstanding the decreased total value of Gold Coast trade the quantity of cacao exported was the highest on record, namely 238,068 tons. Cacao is the staple product of the country and in 1929 the value of the exports of this commodity was £9,704, 493, which represented 78.26 per cent. of the total value of the domestic exports. The percentage of exports contributed by the three Provinces for the past three years is tabulated below:—

	1927. *per cent.*	1928. *per cent.*	1929. *per cent.*
Eastern Province	47.2	41.7	43.4
Central Province	16.9	21.9	19.2
Western Province (includes Ashanti)	35.9	36.4	37.4

Central Province ports have not maintained the margin of increase shown last year but are still above 1927. Eastern Province ports show a slight increase which may be due to heavier yields in the area. With the improved facilities available at Takoradi and supplies coming through from the Central Province Railway, definite increases may be anticipated from Western Province ports.

* * *

Ecuador.

According to the latest report issued by the Department of Overseas Trade and compiled be Mr. R. M. Kohan, the economic and trade conditions of the country have deteriorated to a considerable extent since 1928. "Witch Broom" disease which appeared in Ecuadorean plantations in 1921 and spread throughout the cocoa zones, has had a disastrous effect on the agricultural wealth of the country and is to a large extent responsible for the present economic crisis. The exports of cocoa and coffee in 1929 represented only 38 per cent. of the total value of exports as compared with 48 per cent. in 1928. It will be observed from the following figures of the cocoa output to what extent this product has suffered since 1924. In 1921 the output reached almost one million quintals:—

	Quintals (of 100 lb.)
1924	626,447
1925	658,051
1926	406,420
1927	429,170
1928	410,967
1929	335,052
1930 (Jan. to June) ..	283,368

It is estimated that the 1930 crop will reach 400,000 quintals. In 1916 Ecuador was the second largest supplier of cocoa in the world. In 1928 it occupied the fifth place, and in 1929 it probably occupied the sixth or seventh place. The exports of cocoa in 1929 were 18,208,275 kilos, valued at *S. 21,256,296, as compared with 22,960,873 kilos, valued at S. 29,653,059 in 1928, a decrease of 4,752,598 kilos, representing a value of S.8,396,763.

* S. Equals two shillings (2*s.*)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

The Effect of Green Manuring on the Nitrogen Content and its Relation to the Maintenance of Fertility in some Nigerian Soils.*

In Southern Nigeria the land is usually worked on a system of shifting cultivation; that is to say, the native farmer crops his land, without the application of any fertilising material, for about four to six years, when it becomes exhausted and is then allowed to revert to "bush." The farmer then moves his farm on to newly cleared "bush."

Such a system of shifting cultivation is uneconomic. Efforts have therefore been made to try to develop a system of continuous cultivation by maintaining the fertility of the soil through green manuring. The results of field trials of this system were distinctly encouraging, and investigations were then undertaken to ascertain the effect of green manuring on the fertility of the soil from the chemical point of view. The moisture, nitrate, and total nitrogen content of a number of suitable plots were determined at monthly and later at weekly periods.

The nitrate content of the plots was found to fluctuate rapidly, there being two well-marked periods of maximum concentration. The first period occurs in May and June and the second in September. The minimum concentration occurs during the wettest period of the year, viz., from the end of June to the end of July. This minimum concentration is thought to be due partly to lessened bacterial activity, following the period of maximum activity, and partly to losses by leaching. During the dry season the nitrate content is low and in uncultivated "bush" soil conditions are unfavourable to nitrification throughout the year.

Contrary to normal experience the total nitrogen content of the soil was also found to fluctuate rapidly. Considerable nitrogen fixation takes place, increases of as much as 500 lb. of nitrogen per acre having been recorded. Such large increases are usually followed by correspondingly large decreases, the denitrification taking place under aerobic conditions. It is possible that Azotobacter, which is known to be present in these soils, is the most active agent in this non-symbiotic fixation. Some of this non-symbiotically fixed nitrogen becomes available as plant food. The amount of fluctuation of the total nitrogen content is affected by green manuring, greater fluctuations having been recorded on the plots that were subjected to this treatment.

The amount of symbiotically fixed nitrogen added by the leguminous green crops appears to be small, and since most of this was found to be nitrified within four to eight weeks from the time a crop was dug in, it follows that almost the whole of this nitrogen must have been used in the next succeeding crop.

The fertility of the soil is thus not greatly affected by the amount of nitrogen applied in green manure, but it is being maintained through the invigorating action of the green manure on the free-living nitrogen-fixing organisms.

* Abstract of a Dissertation for the Ph.D., degree in the University of Cambridge, by W. E. de Diamond.

* * *

Cacao Shell.

An interesting review of the uses and potentialities of the shell of the cacao bean is given by A. W. Knapp, M.Sc., F.I.C., in a recent issue of *Food Manufacture.*

Cacao shell is a dry, crisp, brown husk with a pleasant odour. It has a fairly high nitrogen content usually about 3 per cent. The shell contains from 1 to 1.5 per cent of the alkaloid, theobromine, which contains nitrogen in its structure. Only a portion of the total nitrogen, therefore, is available in the amino or protein form. The shell yields about 3 per cent of a fat resembling cacao butter. About 20 per cent. of shell is soluble in water. On ignition, about 8 per cent of ash is obtained.

The shell is used at present in a number of ways, but in quantities which are insufficient to utilise more than a small proportion of the total production. Great Britain produces annually about 5,000 tons.

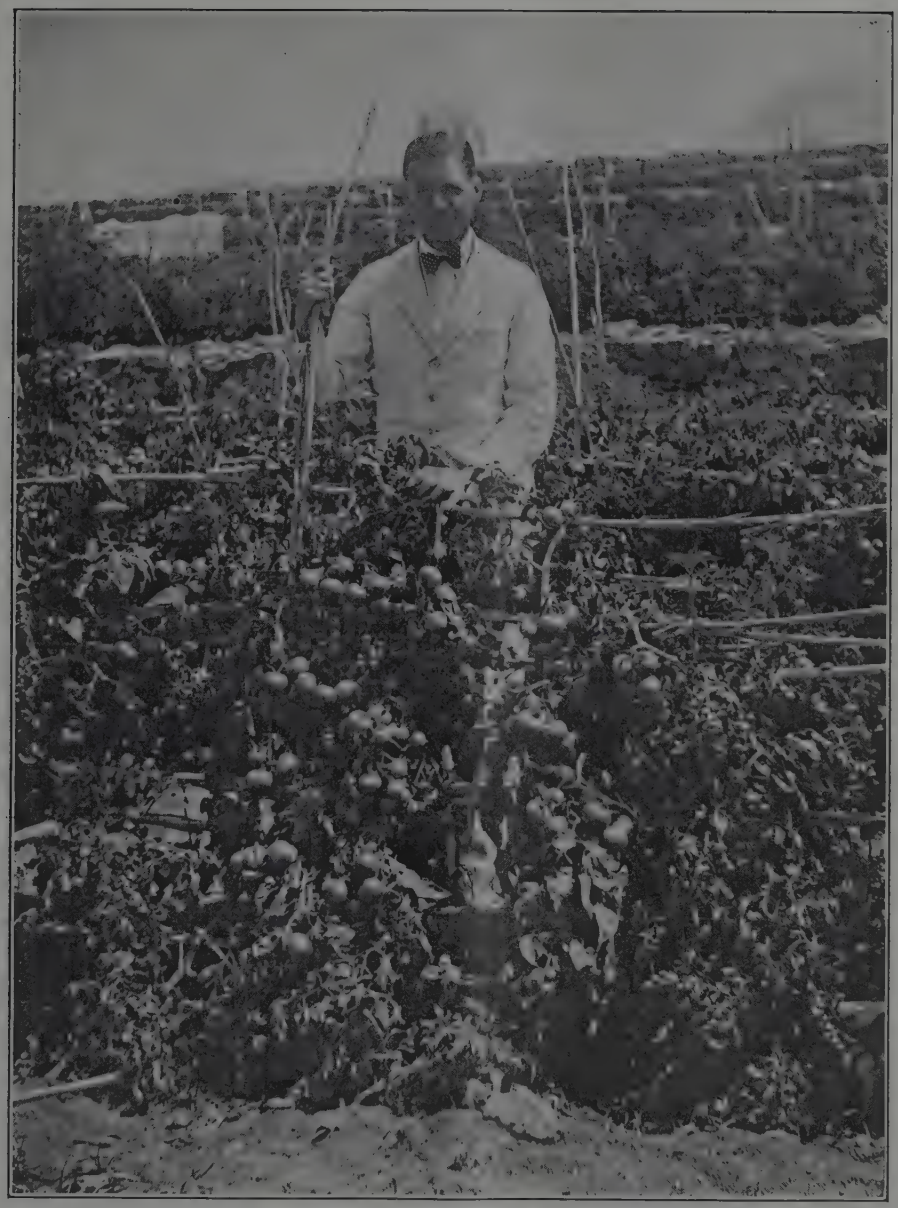
A very poor grade "chocolate" may be produced by substituting ground cacao shell for ground nib in the normal process for manufacturing chocolate. The introduction of ground shell as an adulterant of cacao powder, at one time a profitable industry, has been prohibited.

The comparatively high solubility of the shell in water has led to its use in Ireland as the basis of a drink made with the aid of boiling water. Beyond the Irish demand, there appears to be a very small market for this cacao shell tea.

The major use of the shell at present is as an ingredient of cattle cake. Cacao shell differs from other fodders in that it contains a valuable stimulator and appetiser in theobromine. In excess, theobromine may be toxic to animals. It is dangerous, therefore, to feed the shell un-mixed with other fodders. It is more suitably incorporated as an accessary in cattle cake. Many successful experiments have been performed to show that cacao shell in suitable quantities is an excellent fodder for most livestock. Not only does it act as a stimulant, but it is more than equivalent in food value to any nutrient it may replace in a normal ration.

Other uses are suggested for cacao shell by a study of its composition. The fat it contains may be extracted and when refined obtains a relatively high price. The small quantity present, however, may make the extraction unprofitable. Theobromine may be extracted from the shell. The present demand for this drug, however, is insufficient to require the use of large quantities of shell. The ash contains about 10 per cent of phosphoric acid and 20 per cent of potash. It should therefore be a valuable artificial fertiliser.

TOMATOES IN THE CANARIES.



(5) A new showing method of supporting tomato vines.

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE.

Photo by *G. A. Gibberd.*

This photograph which was taken from the chimney top of the Sugar Factory, shows the Milner Hostel (extreme left), the Main Building, the Biological Laboratory and the Banana Plots.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Comments on Cane Milling (Roll Grooving).

H. J. B. Scharnberg.

In order to obtain a very high sucrose extraction, it is of the utmost importance that the fibre be as finely disintegrated in the first stage of milling as is mechanically possible. The sucrose in the hard outer rind, and in the nodes of the cane, is quite high (based on total per cent. fibre in cane); the maceration partly saturates the marc side of the fibre, and when expressed again will leave on the same side as that on which it entered. On the other hand, when the cane is well prepared, the water can penetrate from all sides, the fibre becoming thoroughly saturated, under which conditions the sucrose ultimately extracted depends on the amount of water applied, and how efficiently the return maceration is used on the mills. This, of course, is not new theory, but long established fact. Experience in Cuba shows that when grinding cane unprepared by knives the capacity of the mill is limited, especially that of the first crusher. This was overcome somewhat by changing the type and diam. of the crusher; but much better results were obtained by the installation of cane knives, both capacity and sucrose extraction being increased considerably. If, in addition to this, the cane in Cuba were further finely prepared by a second set of knives, a shredder, or other means of disintegration, then results should be obtained similar to those found in Hawaii. However, it was found that if the cane were too well prepared the capacity dropped off at once, there being roller slippage and mill chokes. This was due to the amount of juice expressed by the crusher and first mill being so much greater with the same pressure, the grooving in the feed rolls being unable to take it.

Greater pitch grooving has, therefore, been installed, though little attention was given the traction thereby destroyed. Deep juice grooves are now also to be found in almost all cane rolls in Cuba, and are spaced according to the pitch used in the roll grooving, from four inches in the large grooving to two inches in the smaller being the spacing generally used. They have also been cut in some cases in the lower crusher rolls; and in a three-inch pitch grooved roll with a three-eighths-inch by one inch deep juice groove in each groove the drainage area is increased a little over eight per cent., and would amount to six per cent. in four-inch pitch roll. Claims have been made that these juice grooves give a higher sucrose extraction, but this is hardly possible. While the capacity and efficiency of the mill rolls have been increased considerably by their installation they have nevertheless been quite troublesome. Finely disintegrated cane wedged into these juice grooves is removed by special scrapers, falling into the juice pan, often to such an extent that it is necessary to wash it on the juice screens with return juice. Where deep juice grooves are used in the cane rolls, trouble may also be experienced with the turn plates. The points of the plate entering the juice grooves foul up with fibre, and retard the free movement of the crushed material passing over the plate. In order to increase the drainage capacity of the lower crusher, and cane roll grooving, and to avoid this turn-plate trouble, the grooving in these rolls is now being changed to a smaller degree angle, thus increasing the drainage area. Cross grooving cut in the top rolls has been found to improve the feeding of the cane considerably, but it must not be carried too far.—(*The Inter. Sugar Journ.* Vol. XXXIII, No. 385.)

* * *

Storage Experiments with Raw Beet Sugars.

It was concluded that a raw sugar which has less than two per cent. of moisture can be stored at 50 to 60 per cent. of relative humidity without appreciable change in either water content of affinity quality. The optimum relative humidity for low yielding raw sugar was about 54 per cent., the optimum for the high yielding sugar was about 59 per cent. The keeping quality of a cooled phenolphthalein-alkaline sugar is mainly dependent on the original character of the sugar and its moisture content. Where the quality of the sugar is reasonably good, and where the relative humidity of the air in the warehouse is maintained at the optimum, the affinability and moisture content remain constant, and attack by micro-organisms proceeds slowly. Keeping quality is practically independent of storage temperatures (10° to 30°C.). Hence it is merely necessary to keep a hygrometer in the warehouse and manipulate the temperature so as to preserve the optimum relative humidity. Some experiments were also made with white sugar. The optimum relative humidity in this case was found to be between 60 and 65 per cent., but here, as also in the case of raw sugar, the results depend on the ash content. This is due to the fact that syrup films of unlike purities and the general composition of the sugar result in different vapour pressures that lead to differences in the equilibria of the three-phase system sugar: syrup film-air moisture.—(*International Sugar Journal*, Vol. XXXIII, No. 386.)

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Cane Windrower.

A windrowing machine invented by S. Thornton, which was observed to work perfectly in straight cane, cuts and neatly piles two rows of cane at the rate of three to five acres an hour. It consists of a frame mounted on a crawler type tractor the wheels of which straddle two rows of cane. Revolving discs similar to those used on stubble shaving machines cut the canes at the ground level and steel plates direct the cut canes into the middle windrow. Long arms in front of the machine help to keep it in the rows and guide the cane stalks into the discs. A 40 horse power gasolene motor supplies the power. Three men are necessary to operate it, one apiece to raise and lower each disc and one to steer. —(*International Sugar Journal*, Vol. XXXIII, No. 386.)

MYCOLOGICAL NOTES.

A Sclerotinia Disease new to Banana Fruit, and its Relation to Citrus. By I. Reichert and Esther Hellinger.

A new rot of bananas, caused by *Sclerotinia sclerotiorum*, occurred in a very severe form in the Jaffa and Jericho districts of Palestine during the winter of 1929-30. Special importance is attached to this disease in the localities in question on account of the pathogenicity of the causal organism to citrus.

Infection usually begins at the distal end of the fruit and extends towards the stem end. The diseased parts are at first brownish and water soaked in appearance, later dark brown. The mycelium of the fungus is seldom visible, but sometimes an incipient sclerotial structure may be seen, formed from a whitish, later blackish, compact mass of hyphae. The inner tissues show a reddish discoloration which is most conspicuous along the innermost part of the carpellary wall, especially the placenta in the middle. At a more advanced stage of decay the inner tissues turn reddish-black, then black, and finally break down and become hollowed. Sclerotia are produced within as well as on the surface of the fruit.

In badly rotted fruit the mycelium occurs in the starchy pulp at the centre, in the parenchyma of the peel, and (to a slight extent) round the inner vascular bundles, while the outer cortex is free from the fungus. The reddish discoloration was observed to occur in advance of actual invasion by the parasite, indicating that the latter exerts a toxic action on the cells before entering them.

So far only the sclerotial stage of *S. sclerotiorum* has been observed on diseased bananas in the orchard, but the fertile fruiting stage is considered likely to occur in the soil. Probably the sterile flowers hanging beneath the fruits may also harbour the fungus. Inoculation experiments with fragments of mycelium from agar cultures in February, 1930, gave positive results on wounded and unwounded bananas. Repetition of the experiments on 7th and 19th August at a temperature of 28° to 30°C. gave negative results, showing the inability of the fungus to develop at a relatively high temeperature and low humidity, and explaining its disappearance from the groves towards the end of April. Inoculation tests on wounded and unwounded oranges with *S. sclerotiorum* from a diseased banana also gave positive results, the fruits being thoroughly rotted within a few days and covered with a whitish, flocculent mycelium giving rise to large sclerotial masses. The disease occurred in a severe form on bunches of bananas tightly enclosed in sacks, and left for a considerable time before cutting and marketing, infection spreading rapidly from one fruit to another by contact.

S. sclerotiorum has been found in Palestine attacking eggplants, lettuce, cabbage, and citrus twigs. Control measures should include free access of air to the fruit, periodical inspections of the groves, and spraying with ammoniacal copper carbonate (150 gm. copper carbonate 1.5 l. ammonia, and 200 l. water) or ammoniacal Burgundy mixture (2 kg. copper sulphate, 2.5 Kg. sodium carbonate, 1.5 l. ammonia, and 200 l. water).

The potentially formidable character of the *Sclerotinia* disease is very important especially in relation to the important citrus industry of Palestine.—(*The Review of Applied Mycology*, Vol. X, Part 2.)

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Virus Disease of Plants.

A new method of attack has been used by the workers on virus diseases at the Rothamsted Experimental Station. They have realised that the virus should be studied in the environment in which it is most active, namely, the living host, and Dr. J. Caldwell has recently published results of the first part of his work on the "Physiology of Virus Diseases in Plants" (*Annals of Applied Biology*, Vol. 17, pp. 429-443). He has studied the passage of the virus of yellow mosaic in the tomato plant, finding that the movement was inhibited by the treatment of part of the stem with chloroform and was also effectively controlled by steaming an area on the stem. There was no localisation of the virus on one side of the stem as might be expected from movement through vascular tissue after a one-sided inoculation, nor did the virus behave as did red ink or particulate substances, both of which passed across the open xylem vessels of the steamed area. It was concluded that the movement takes place in the living ground tissue of the plant.—(*Nature*. Vol. CXXVI, No. 3183.)

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Slime Fungi in Soil.

C. Thom and K.B. Raper direct attention to the constancy with which amoeboid forms of the Myxomycetae or slime fungi can be obtained from samples of soil and from the decaying vegetation on the surface of the soil, in a paper in the *Journal of the Washington Academy of Science* (Vol. 20, No. 15, Sept. 19, 1930.) They suggest that the group of organisms may have been rather neglected in studying the soil population, and that the amoebae of the soil, which have received very considerable attention from soil workers of the last generation, may usually include a strong representation of this group, especially when the soil temperature is not too high (not above 18°C.) The plasmodia and motile amoebae observed were generally obtained on mannite agar on which suitable samples of the soil or vegetable detritus had been placed; when sporangia were obtained the genus *Didymium* was usually identified.—(*Nature*, Vol. CXXVI, No. 3183.)

REVIEWS.

Diseases of Animals in Tropical Countries.

By C. R. Edmonds and C. K. Walker. Second Edition. *Bailliere, Tindall & Cox.*

The authors who have had considerable experience in administrative, research and general veterinary work as well as veterinary education in the tropics, have written a book which is a very valuable addition to veterinary literature. The introduction in itself should be extremely useful to all students engaged in veterinary work and animal husbandry. The main contents, divided into three parts, deal with (i) diseases caused by vegetable parasites, (ii) animal parasites, and (iii) the undetermined viruses. The subject matter is up to date and illustrated by excellent photographs and diagrams. It is rather a pity that the authors have given such a detailed account of the vegetable parasites of diseases like Actinomycosis and Swine Erysipelas as they are very rarely seen in the tropics; likewise in the case of Tuberculosis and the diseases of the udder the descriptions seem rather too exhaustive as most of the information is already available. No mention is made of the relationship between Malta Fever in man and contagious abortion in cattle. The four classical diseases caused by trypanosomes are accurately described but it is hoped that the authors will treat them in greater detail in their next edition, along with the very important diseases caused by other trypanosomes. This work should not only be used as a textbook for veterinary students who are to be specially trained for services in India and the Colonies, but should form a most useful reference book to Veterinary Officers already in these services and no Agricultural Officer's library will be complete —especially those engaged in animal husbandry —without it.

H. V. M.

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Chemical Engineering and Chemical Catalogue.

Sixth Edition, 1930. *Leonard Hill, Ltd.*, 231-232, Strand, London.

This is a catalogue of chemical substances, raw materials, machinery, plant and equipment applicable to various industries, compiled, with the co-operation of leading British Manufacturers, by Dr. D. M. Newitt. It furnishes a useful book of reference to manufacturers. Its list of products runs into some 2,000 items, and is set out both in English and in Spanish. It is not a book of advertisements, but aims rather at providing a link between the supplier and the practical man, so that the latter might the more readily be able to select the right sort of material and plant for any specific use. The various industries considered include agriculture; distilling; cement making; solvent extraction; fertilizer, insecticide and fungicide manufacture; oil refining; paint, paper, leather, linoleum, match, mineral-water, perfumery, wood preservative, drug, rubber, soap, starch, sugar, resins, artificial silk and tobacco manufacture; as well as refrigeration, road-making, water-proofing and water-softening. The index makes it easy to discover where to apply in Great Britain for any particular material or plant required in any particular industry, and the fact that many tropical plantation industries are included in its scope, renders the book of considerable value to those contemplating new enterprises.

F. H.

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Nelson's Geography of the West Indies and Adjacent Lands.

By J. O. Cutteridge. *Thomas Nelson and Sons Ltd.*, London, pp. 328. Price 2*s.* 8*d.*

Mr. Cutteridge's book is indeed a very worthy successor to his *West Indian Readers.* Profusely illustrated with excellent diagrams, maps and photographs, it has been divided into three sections consisting of (i) a general survey (ii) a detailed survey of the West Indies and adjacent countries followed by (iii) a discussion of the world relations of the West Indies. The first section contains, amongst other things, particularly welcome chapters dealing with plant and animal life and agriculture, while in the second section each of the British West Indies is treated under the headings of size, build, soil, climate, production, population, communication and trade, interesting information also being given on these subjects with regard to the American, French and Dutch territories. The book should be extremely popular amongst children as the information which it contains is presented in a manner which could not fail to interest them. This geography is not only to be commended for school work, but should find a place in most libraries as a book of reference. It has certainly filled the need for a local textbook on geography.

G. G.

BOOKS RECEIVED.

We have to acknowledge receipt of the following Books :—

CHEMISTRY.

The Physical Properties of the Soil. B. A. Keen. *Messrs. Longmans, Green & Co. Ltd., pp.* 380, 21*s.*

GENERAL.

Nelson's Geography of the West Indies. J. O. Cutteridge. *Messrs. Nelson's & Sons,* pp. 328, 2*s.* 8*d.*

We have also to acknowledge, with thanks, the following books which have been presented to the Library :—

The Cocoa and Chocolate Industry. A. W. Knapp (2 copies). Presented by Messrs. Cadbury & Co.

The Coconut Moth in Fiji. Tothill, Taylor and Payne. Presented by Dr. Tothill.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.):

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
26th February ...	6	2¼	9	11¼
5th March... ...	5	11¼	9	8¼
12th March... ...	6	0	9	9
19th March... ...	6	3	10	0
26th March... ...	6	6	10	3
2nd April	6	6	10	3
9th April	6	6¾	10	4½

Since our last Report there has been a general period of quietness, the trend of the markets being barely steady. According to *C. Czarnikow Ltd.*, the underlying confidence in the ultimate betterment of market conditions in the more distant future has not been shaken, as there is evidence of the probability of material reductions being made in areas to be put down to Beet this year. A Licensing Law providing for the limitation of exports from Java to conform with the Chadbourne Plan has been passed by the Java People's Council. The rapidity with which the market will respond to altered statistical conditions will depend on the measure of confidence which is placed in the Chadbourne Plan.

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COCOA.—The market, if anything, is a little firmer, due no doubt to farmers on the Gold Coast endeavouring to secure higher prices for the balance of their holdings. In addition to this, stocks in principal centres are not excessive and normal buying would strengthen the situation. Even at present low prices buyers are not taking in stock what they would in normal conditions. —(*By courtesy of The Cocoa Planters' Association of Trinidad.*)

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RUBBER—Quotations for Plantation Sheet have ranged as follows:—

	d.
25th February	3¾
4th March	3 9/16
11th March	4
18th March	3 15/16
25th March	3 9/16
1st April	3 6/16
7th April	3¼

Various fluctuations in prices occurred during the four weeks period ending 18th March, the market then developing rather pronounced weakness. Negotiations have recommenced between British and Dutch Rubber interests with a view to the introduction of compulsory restriction under Government control.

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COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association:—

	American Mid.	*Egyptian F. G. F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
20th Feb.	6·04	9·70	19·00	34·00	—
27th Feb.	6·18	10·35	18·00	34·00	15·00-17·00
6th Mar.	6·09	9·85	18·00	34·00	7·50- 9·00
13th Mar.	5·97	9·55	18·00	34·00	18·50
20th Mar.	5·95	9·80	18·00	34·00	17·50
27th Mar.	5·85	—	18·00	34·00	—
4th Apr. (local)	5·76	—	17·00	33·00	—

The market on the whole has remained steady although the weakness of Alexandria has had an unsettling influence on sentiment. Strong interest is still being shown in growths other than American.

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TEA AND COFFEE.—The most recent quotations are as follows; Costa Rica 100*s.* to 148*s.* per cwt., Kenya, 76*s.* to 129*s.*, Jamaica up to 200*s.* for Blue Mountain, Rio 50*s.* The downward trend of tea prices has been checked slightly by the fall in February imports, latest averages per lb. include Ceylon 14.58*d.*; Indian 10.85*d.*; Java 7.00*d.*; the fall in prices in London is chiefly attributed to the inferior quality of the recent tea arrived for sale on Spot and for cash, the poor tea sent by Dutch growers in particular having pulled the averages down.—(*Times Trade and Engineering Supplement*, 21st March.)

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COPRA.—Copra is dull with West Indian f.m.s. a little lower at £15 15*s.* No. 2 contract term c.i.f. London or Rotterdam.

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BANANAS.—Bananas have been in fair demand, and there is an improving tendency. The prices quoted by Elders & Fyffes and the Jamaica Producers are about £1 higher on the fortnight at £19 5*s.* per ton delivered London, and £19 delivered nearest railway station. Brazilians are unchanged at £18 per ton delivered nearest railway station.—(*West India Committee Circular*, 19th March.)

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LIME PRODUCTS.—*Lime Oil.* Small sales of Handpressed have been made at 40*s.* to 45*s.* per lb. Owing to the scarcity of Distilled up to 36*s.* per lb. has been paid for a small parcel on the spot. *Lime Juice.* There is no demand yet for Concentrated and the quotation (£8) is nominally unchanged. *Raw* is quiet and unchanged at 1*s.* 6*d.* to 3*s.* per gallon according to quality.—(*West India Committee Circular*, 19th March.)